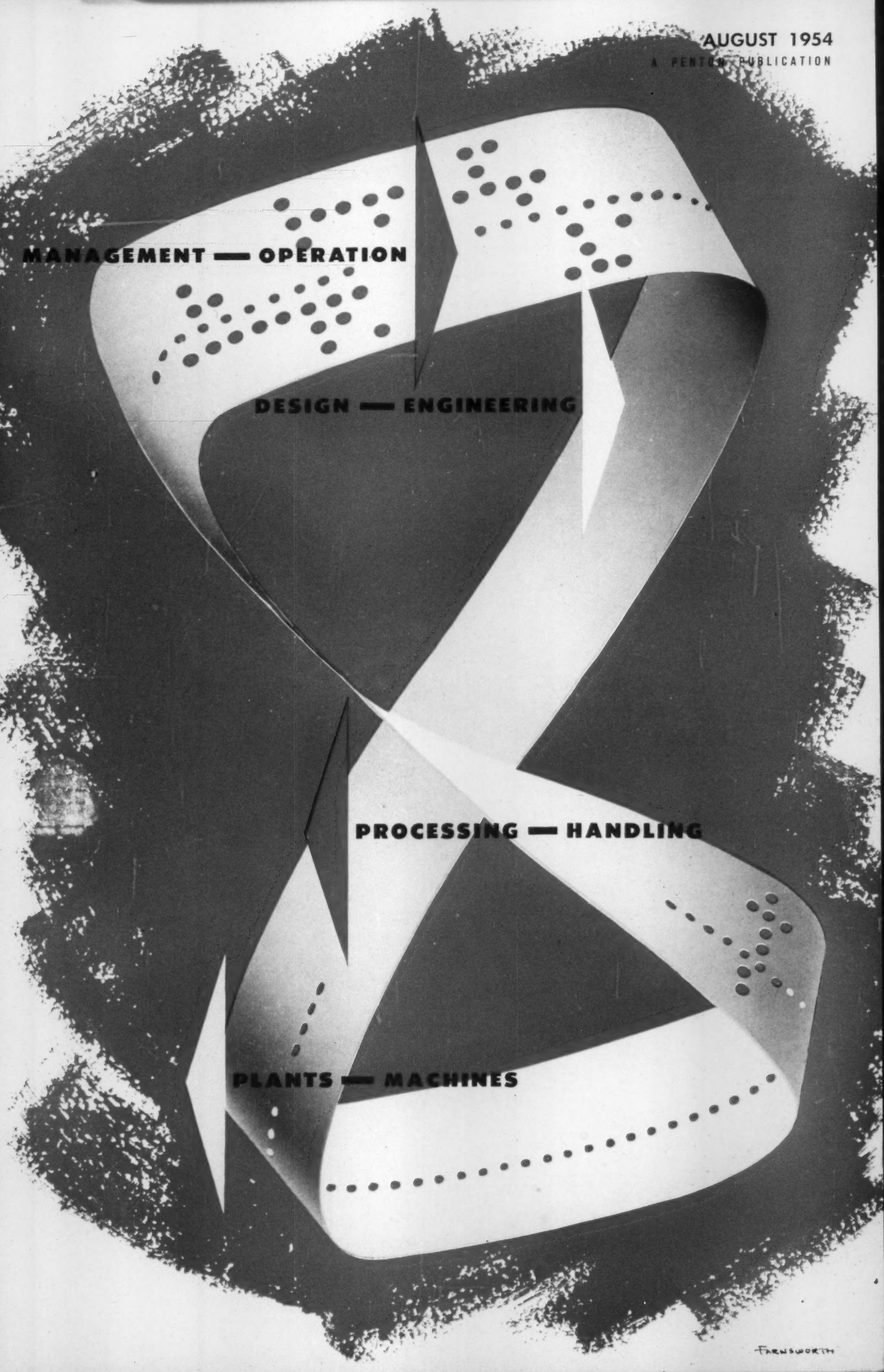
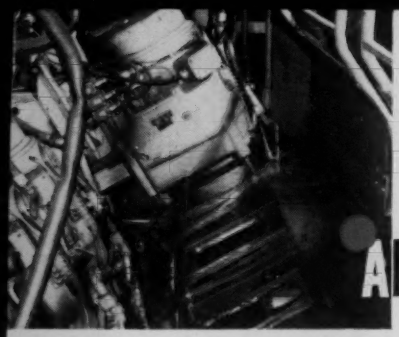
AUTOMATION

AUGUST 1954
A PENTON PUBLICATION





AMAZING "AUTOMATED" DRILL-GRINDER TEAM

DOES THE JOB 22 TIMES FASTER

Machining mounting surfaces on the underside of huge tank hulls required ten separate horizontal boring mill setups. Handling, positioning and working on the heavy, unwieldy hulls created a serious bottleneck in production.

Relying on Wean Equipment's reputation as a leading designer and builder of special machinery for industry this concern gave Wean the green light. Wean Equipment engineers set to work and came up with the first completely automatic adaption of a bank of grinding heads to work on an angular surface.

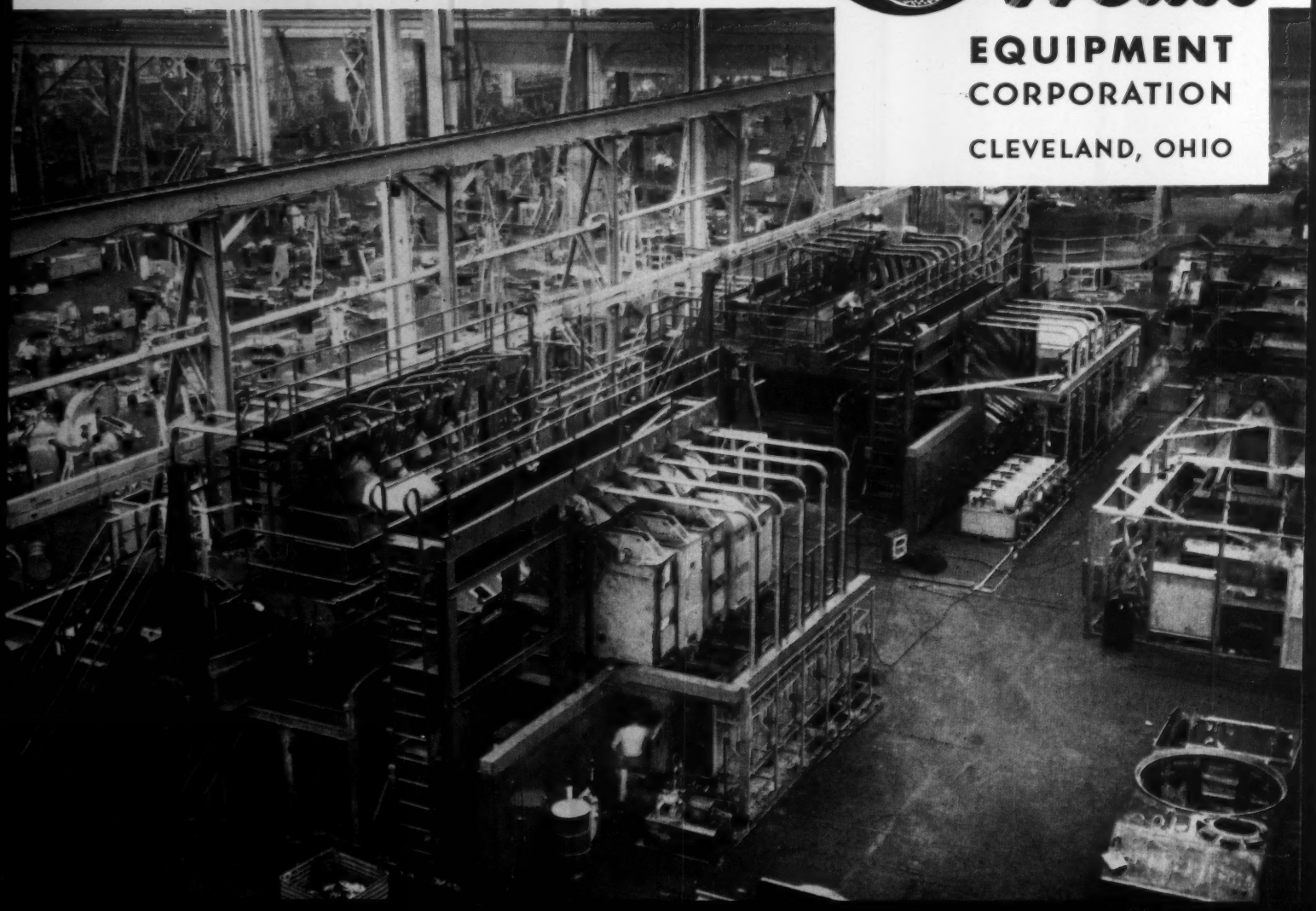
The machine grinds all surfaces simultaneously with unmatched precision, and completes its job 22 times faster than the old method. According to company officials the machine paid for itself in short order by increasing production, eliminating reworking created by human error, and releasing boring mills to other production work. Result: A second machine to perform a difficult drilling operation on the same hull was ordered from Wean. These are typical examples of Wean Equipment's ability to develop and build practical automation equipment.

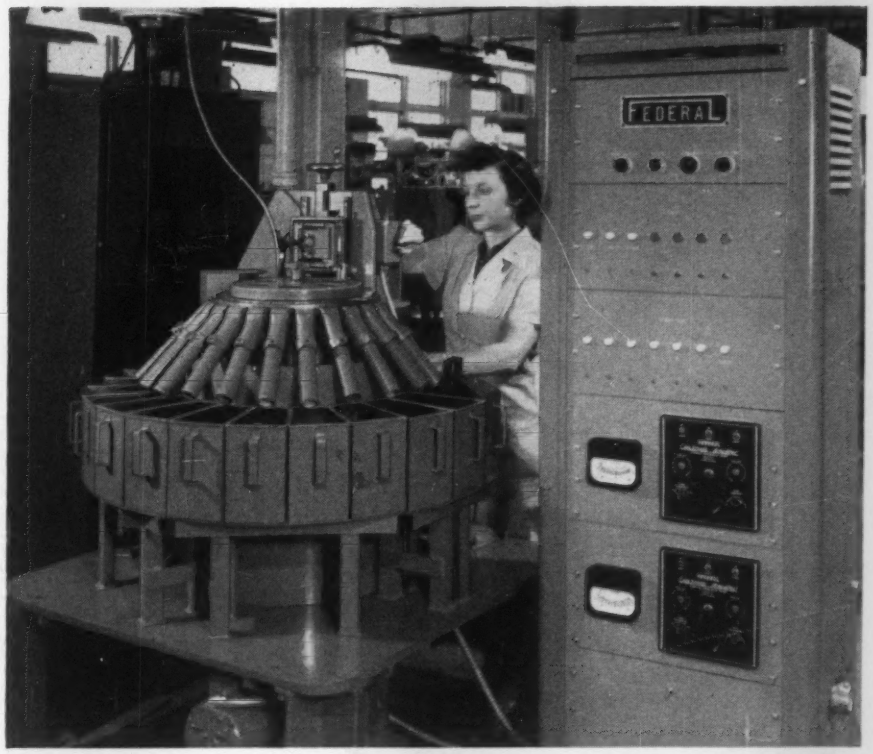
If you have a production problem — why not call on Wean Equipment and get results.

Wean

EQUIPMENT
CORPORATION

CLEVELAND, OHIO





100% Inspection Pays as this Federal Electronic Sorting Gage automatically measures 8000 roller bearings an hour. It checks their O.D. and length . . . sorts into 12 acceptable classifications 0.0001" apart . . . sends off-size bearings to "scrap" or "salvage".

100% Inspection Is Now Profitable!

Quality vs. Cost is no longer a battle in many mass-production plants. Their process, production and quality control engineers have struck a perfect balance. They did it by installing high-speed measuring, dimensional control and sorting equipment in their production lines.

How can you improve quality while increasing profits? It's easy to find out. Just send for the bulletin "High-Speed Automatic Gaging and Sorting by Federal". It shows how Federal automatic gages are achieving results like these:

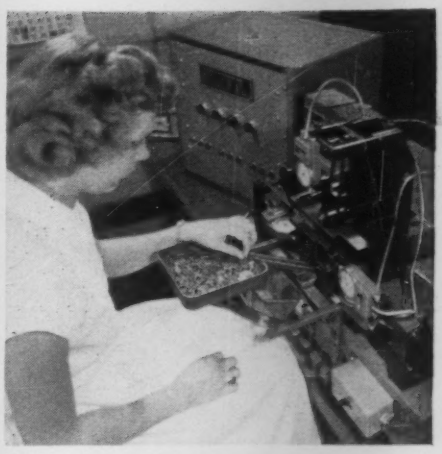
1. **Slashing rejects as much as 35%** while sorting into 16 size categories 0.0001" apart.
2. **Maintaining accuracies of better than 0.00005" all day long** by measuring work in process and automatically adjusting the machine to hold tolerances.
3. **Inspecting and sorting for 9 separate specifications** at a speed of more than 3000 pieces an hour.
4. **Sorting 7200 odd-shaped pieces an hour** into 5 "good" groups while rejecting "bad" pieces for either of two wrong angles.

Seeing's believing! These and more than 40 other case studies are covered in detail in Federal's bulletin 72 on "High Speed Automatic Gaging and Sorting". It will help your engineers: (1) Federal has already solved your sorting or dimensional control problem; (2) An existing Federal gage may be easily adapted for your purposes; or (3) Federal engineers can develop the gage that will make 100% inspection pay off for you. So, write for your copy today. Federal Products Corporation, 4398 Eddy Street, Providence 1, R. I.

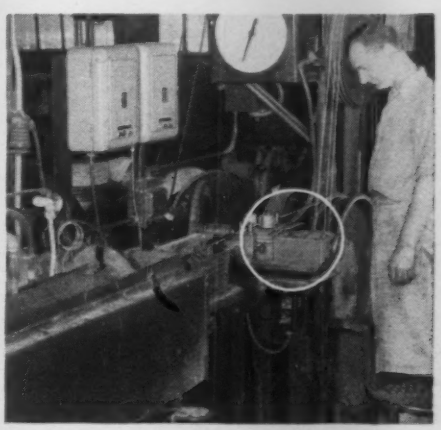
Ask **FEDERAL**

FOR ANYTHING IN MODERN GAGES...

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting or Machine Size Control



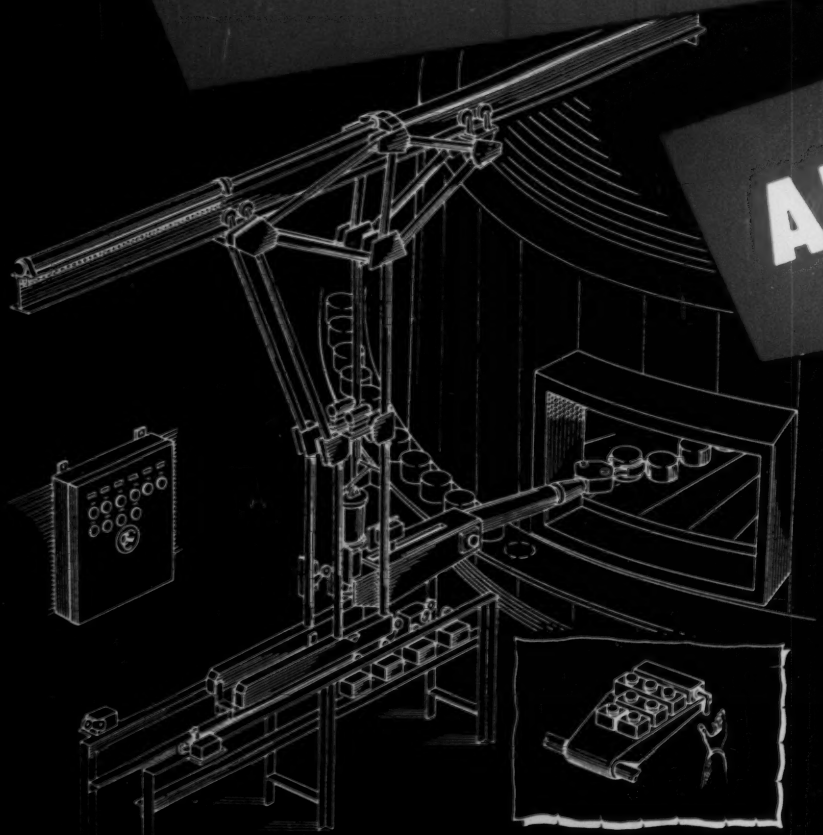
Quality Control Costs Less with this Federal semi-automatic electronic sorting gage. It simultaneously measures four dimensions of plastic sleeve assemblies . . . divides pieces into four categories: (1) All dimensions good; (2) O.D. oversized; (3) I.D. of holes undersized; (4) rejects.



Production is More Uniform with this Federal machine-control, continuous-measuring gage. It automatically speeds up or slows down the wire coating machine to maintain a uniform thickness of plastic or rubber insulation.

Sorting is Faster, More Accurate as this Federal automatic gage measures and sorts automotive piston pins at a rate of more than 3000 an hour. Located at the exit side of a centerless grinding machine, it also directs acceptable pins to packagers.

How's This For — AUTOMATION?

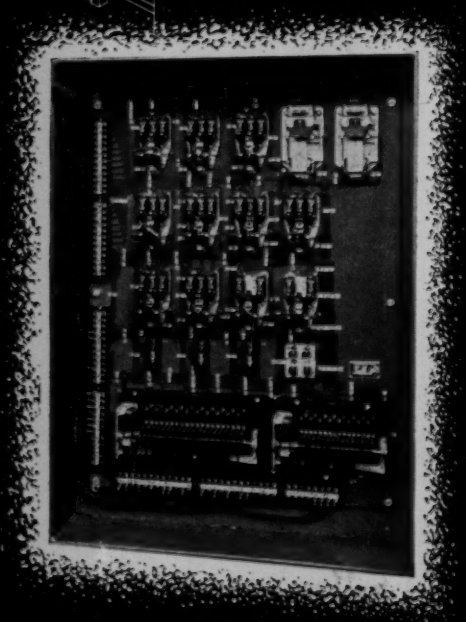


This mechanical hand is called a Billet Charging Machine. It automatically loads cylindrical steel billets into a rotary furnace, one row at a time, to be heated for forging.

The machine picks up a billet from the conveyor and sets it down inside the furnace. It repeats this operation until it has lined up a full row of billets. A selector switch determines whether there shall be three or four billets to a row. The cycle is repeated when the furnace rotates to the next loading position.

Seven separate motions are required to load each billet. Thus the complete cycle involves either 21 or 28 individually controlled motions for the row.

The Billet Charger was designed by E. Homer Kendall, Consulting Engineer, of Alliance, Ohio and built by May-Fran Engineering, Inc., of Cleveland. The special automatic control panel — the brain of the machine — is Clark designed and Clark built.



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AUGUST, 1954
Vol. 1—No. 1

AUTOMATION

THE MAGAZINE OF AUTOMATIC OPERATION

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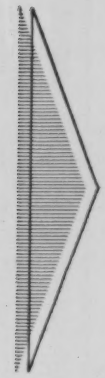

AUTOMATION OUTLOOK

HARNESSING MOTORS

". . . automation, or the system whereby more and more manufacturing operations are successfully tied into a continuous, smoothly flowing production sequence, is a growing field. Solving the problems raised in harnessing motors to the new tasks it has imposed is requiring the closest co-operation among the engineers designing such machinery, the builders of rotating electrical equipment and the manufacturers of electrical and electronic controls. . ."—*Reliance Electric & Engineering Co.*

REDUCE TOLERANCE SPREAD

". . . automation also includes many by-product results, which cannot be included in the actual cost figures of the parts being produced. For example, when a line is completely automated it is possible to reduce the tolerance spread of mating parts because the line must have built into it automatic inspection devices at each of the processing stations. . ."—*C. F. Hautau, chief engineer, Hautau Engineering Co.*

HUMAN CONTROL IMPRACTICABLE

". . . it is a mistake, I think, to suppose that automatic controls have been developed exclusively or primarily because of the attempt to reduce production costs. This is one factor, but not the exclusive one. Among the most important, perhaps, is the fact that modern service and manufactured goods require materials of uniformly high quality . . . many articles in current use must be processed under conditions of speed, temperature and chemical exchange that makes human control impracticable. . ."—*Ernest Nagel, professor of philosophy, Columbia University*

ESSENTIAL ELEMENTS

". . . to accomplish complete automation four elements are essential: (1) work performing mechanisms, (2) actuating controls, (3) computers, and (4) operating programs. . ."—*Philip R. Marvin, Vice President, Commonwealth Engineering Co.* *See Page 34.*

CREATING THE ENVIRONMENT

". . . a business having large volume and great variety can be examined for concepts that can lead to creating an environment conducive to going automatic. . ."—*M. L. Hurni, Management Consultation Services Division, General Electric Co.* *See Page 69.*

NEW DEVICE NEEDED

". . . individual tool programming with machine tools can be used to keep tool change downtime within specified limits . . . lines can be designed and programmed to operate with as little as five per cent downtime . . . the line is divided into sections . . . and a new kind of work handling device is needed for automatic work banking between sections. . ."—*Ralph E. Cross, executive vice president, Cross Co.*

SELL THE BENEFITS

". . . public attitude toward automation is generally pretty negative. People see the displaced labor caused by automatic equipment and cannot, of course, see the benefits. Top management has a real challenge in this field to sell the benefits of automation to all of society. . ."—*G. H. Gustat, industrial engineering division, Eastman Kodak Co.*

AUTOMATION

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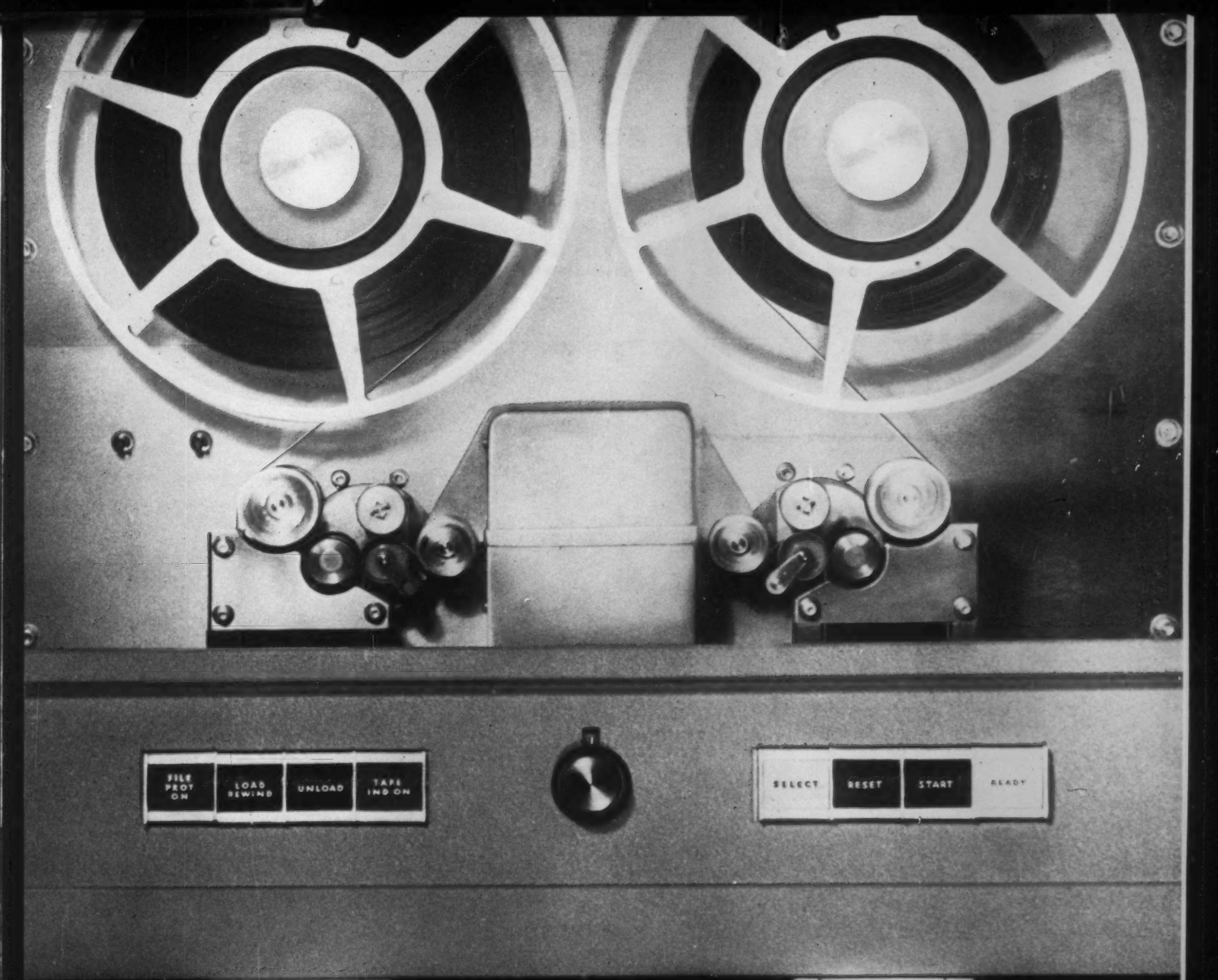

A "Giant Brain" that's Strictly Business

IBM's new 702 Electronic Data Processing Machine brings to the accounting and record-keeping problems of business the speed and capacity of giant scientific computers.

It can absorb millions of facts and figures on its magnetic tapes (shown here), process this vast quantity of data, and turn out the results in the form you need. Payrolls, billing, manufacturing and inventory control, cost allocation, manpower scheduling, fiscal accounting—all the complex operations of modern business—are performed at high speed.

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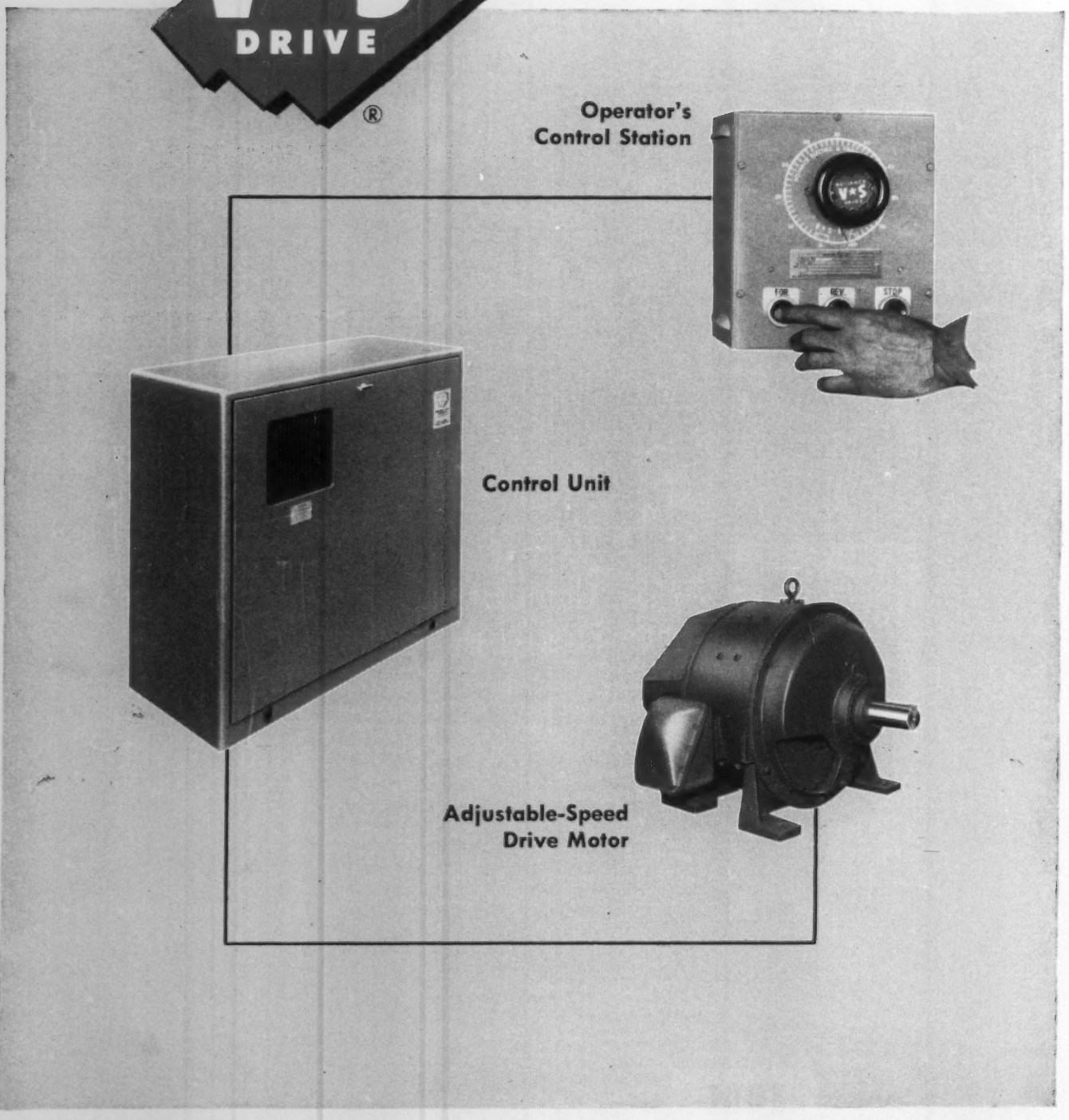

PRODUCTION OUTPUT IN EVERY INDUSTRY

moving things faster...more accurately!

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Precision-Built
MOTORS

Reliance electric motors, adjustable-speed drives, electronic controls, and applied engineering—the Tools of Automation—make it possible to secure increased production in a single machine . . . part of a process . . . or an entire factory.

And these tools provide all the dependability and economy you need to get complete benefits of automated equipment. They have established an unequaled record of performance under the most exacting operating conditions in industries like textile, chemical, steel, metal working and automotive.

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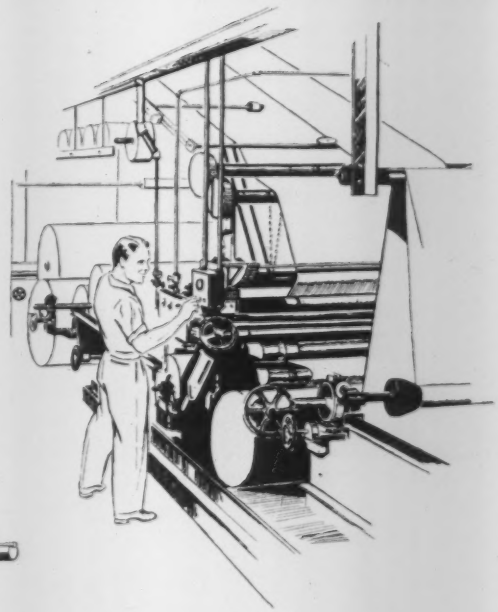
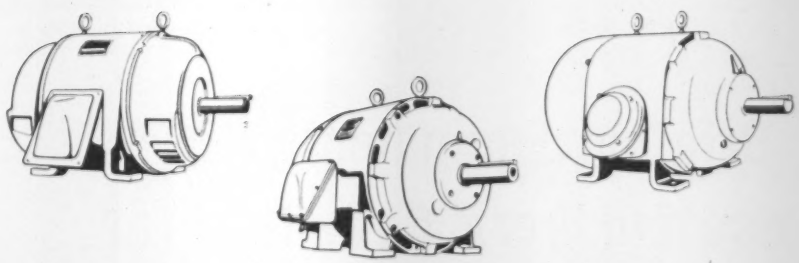
For all the facts, write for your copy of our new booklet, "The Tools of Automation". D-1474





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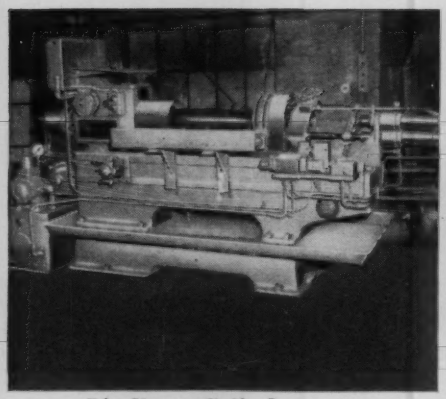
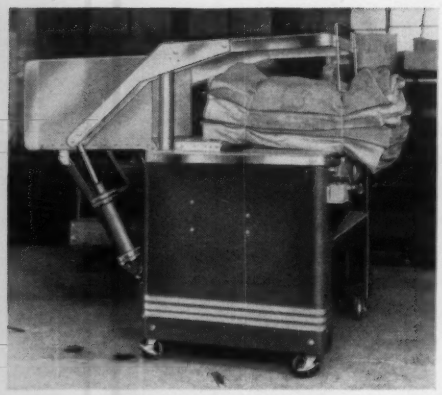
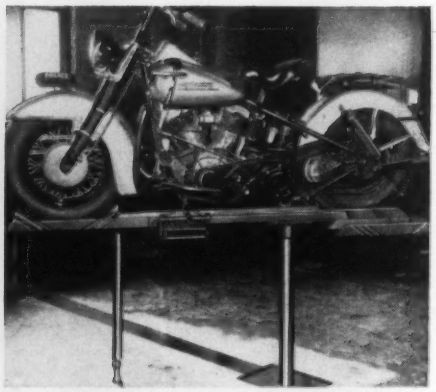


Lindberg Cylinders are used on Machine Tools



. . . and Clamping Machines



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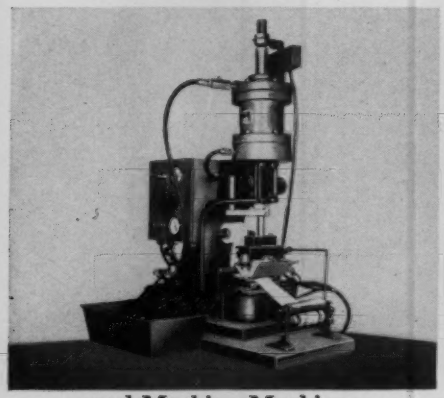

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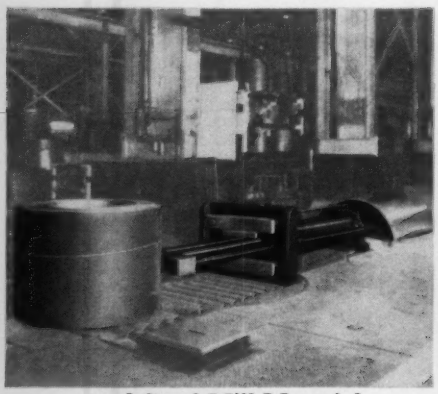

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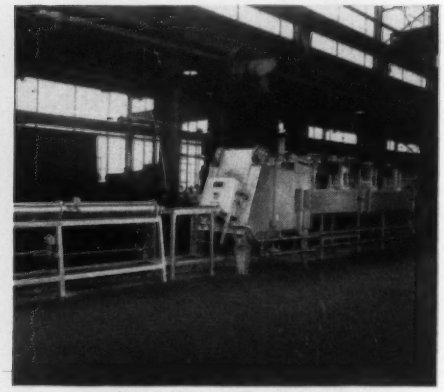
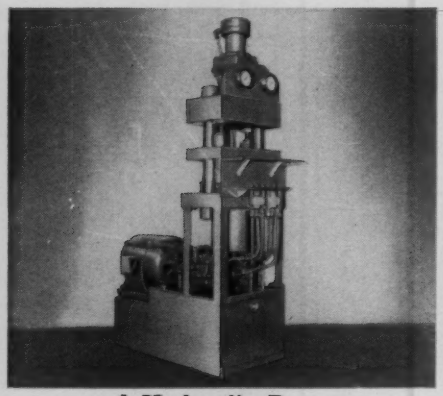


. . . and Heat Treating Furnaces



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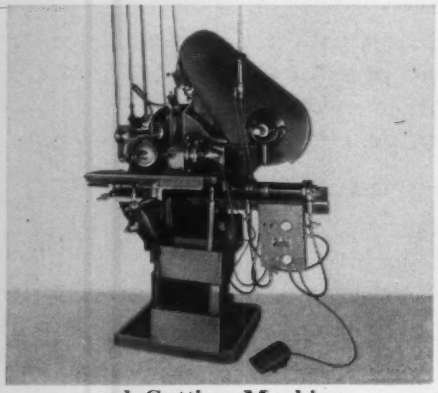

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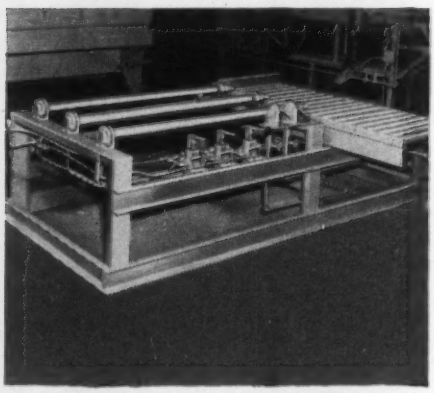

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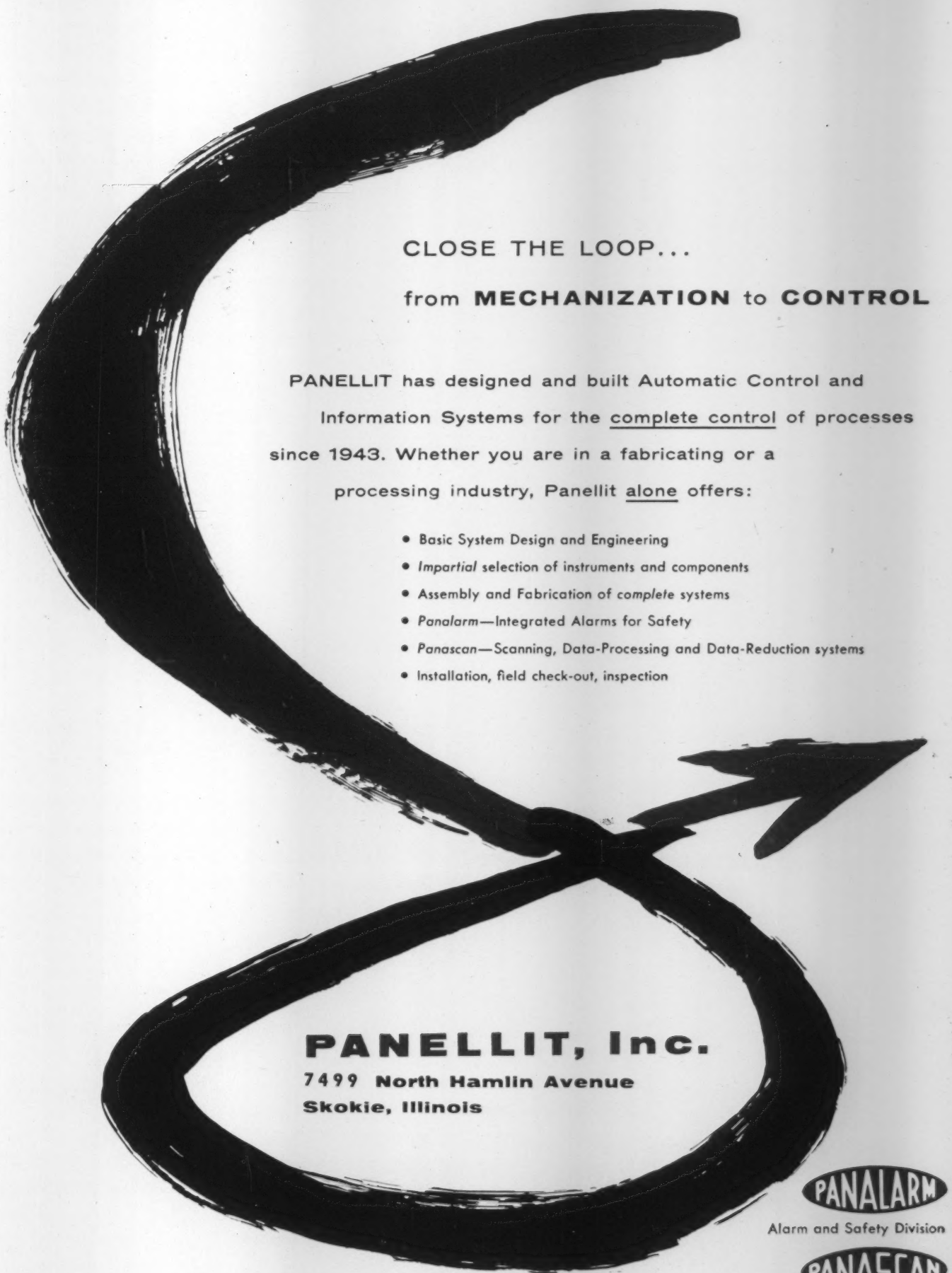

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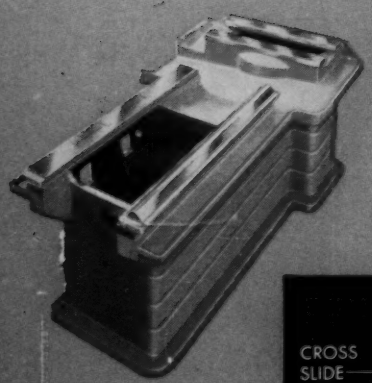
New!

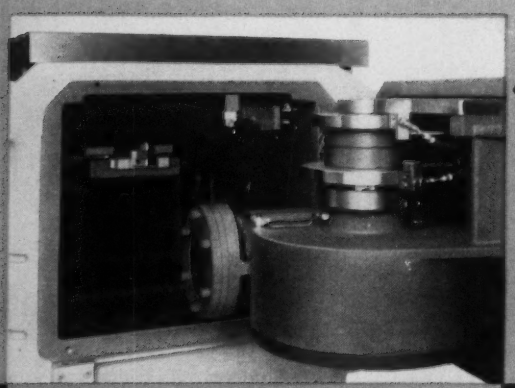
XLO
EX-CELL-O for PRECISION

Flame Hardened Ways

Rugged — For Tough Jobs. The base is a heavily ribbed nickel iron casting.

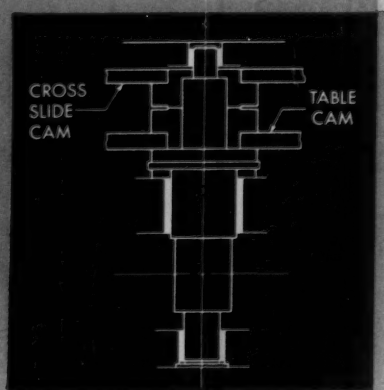
Drawing shows the 3-bearing shaft which supports the cams.





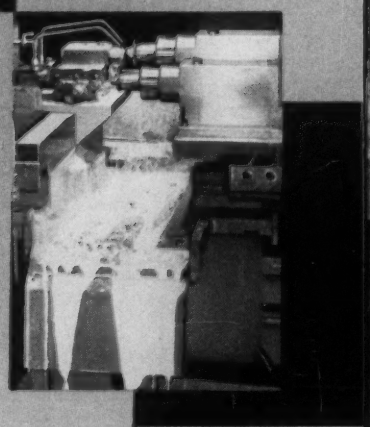
Cams Changed in *Minutes*

Just open the cam compartment and the cam assembly swings out for quick change of operation. All motors are outside the base.



Chip Problem Solved

Large chip chute is cast integral in the solid top of the base. There are no openings; chips or coolant cannot enter the base.



Direct Cam Action

★ NO LEVERS!

IN THE NEW STYLE 312 EX-CELL-O PRECISION BORING MACHINE

★ Fast

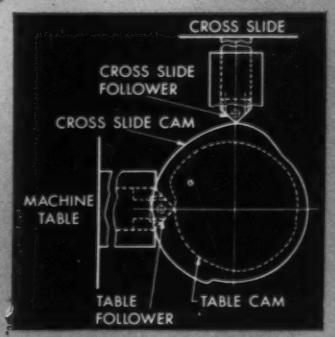
★ Accurate

★ Automatic

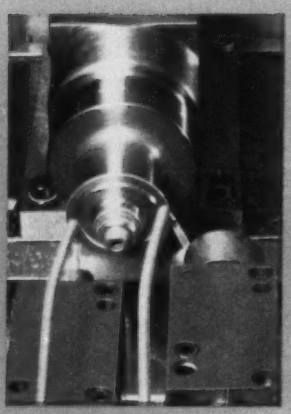
A New Method by EX-CELL-O

Direct Cam Action (NO LEVERS) for Sturdier Control

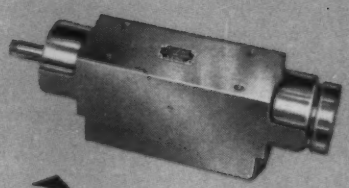
Added to Ex-Cell-O's line of Precision Boring Machines is the new Style 312, for precision contouring, boring, turning, facing and grooving operations.



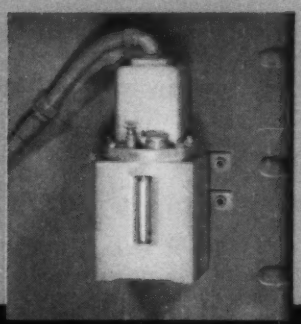
Drawing shows the contouring action. Note that cams act directly on the slides. THERE ARE NO LEVERS. There are separate cams for table and for cross slide, both being on one shaft to insure exact coordination.



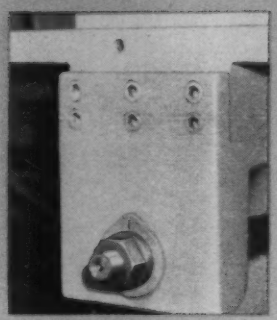
Close-up view of a two-tool contouring operation on an aircraft washer. The part is chucked on the spindle; tools are carried on the cross slide.



Spindle is lubricated permanently.



Ways are lubricated automatically by pump.



Size Control

Graduated adjustment, on end of machine, positions the table relative to the work.

EX-CELL-O CORPORATION

DETROIT 32, MICHIGAN

MANUFACTURERS OF PRECISION MACHINE TOOLS • GRINDING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

54-43

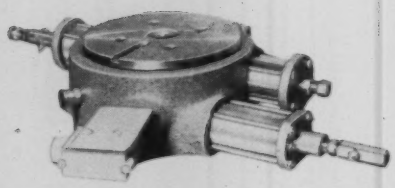
FOR MORE INFORMATION... contact your Ex-Cell-O representative or write Ex-Cell-O in Detroit for literature.

ERICKSON INDEXERS

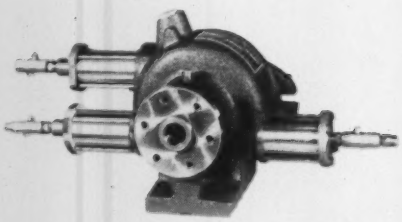
One of these *three* types will answer your AUTOMATIC POSITIONING needs for MILLING, DRILLING, TAPPING, WELDING and many ASSEMBLY OPERATIONS

EXCLUSIVE ERICKSON INDEXER FEATURES:

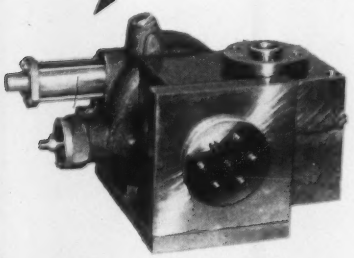
- Index mechanically locked by spring-loaded pin
- Integral shock control unit prevents over-ride
- Three-position indexer available for 120° locating
- Up to 500 positions can be indexed accurately
- Reasonably priced due to ingenious design
- Index plate is easily changed
- Can be operated at any angle
- Operates by air or hydraulics



MODEL 450 ERICKSON SPEED INDEXER is designed for vertical operation. Extra large drive spindle rides on Timken roller bearings at top and bottom of spindle and permits handling of larger and heavier work. This model is suggested for installations where limited height is a factor.



MODELS 400 and 600 ERICKSON SPEED INDEXERS Standard index plate provides 4, 6, 8, 12 and 24 positions. Special indexing parts are available to provide up to 100 positions. Two mounting surfaces provide for vertical or horizontal mounting.



MODEL 477 ERICKSON MULTIPLE POSITION INDEXER accurately indexes up to 500 positions, depending on the gear ratio and index plate employed. Since gear box turns on indexer spindle, unit can be operated in any angle from 0 to 90°. Units are made to customers' requirements.

You can speed up and simplify accurate positioning with Erickson Speed Indexers. For fully automatic operation interlock them in your production line by use of micro switches and solenoid valves. They are designed for single or continuous cycle operation.

All Erickson Indexers feature an adjustable, self-contained shock control unit that assures positive, fast indexing even under heavy load. Maximum speed can be used with no over-ride.

A hardened and ground lock pin operates independently of actuating mechanism to assure positive positioning accuracy within 2 minutes of a degree.

A-9812

Accurate Automatic Positioning Cuts Costs...

Write for Erickson Catalog K today! You'll find many interesting applications for all Erickson holding tools. Take advantage of our free engineering service. An Erickson field engineer will gladly work with you for production economy.

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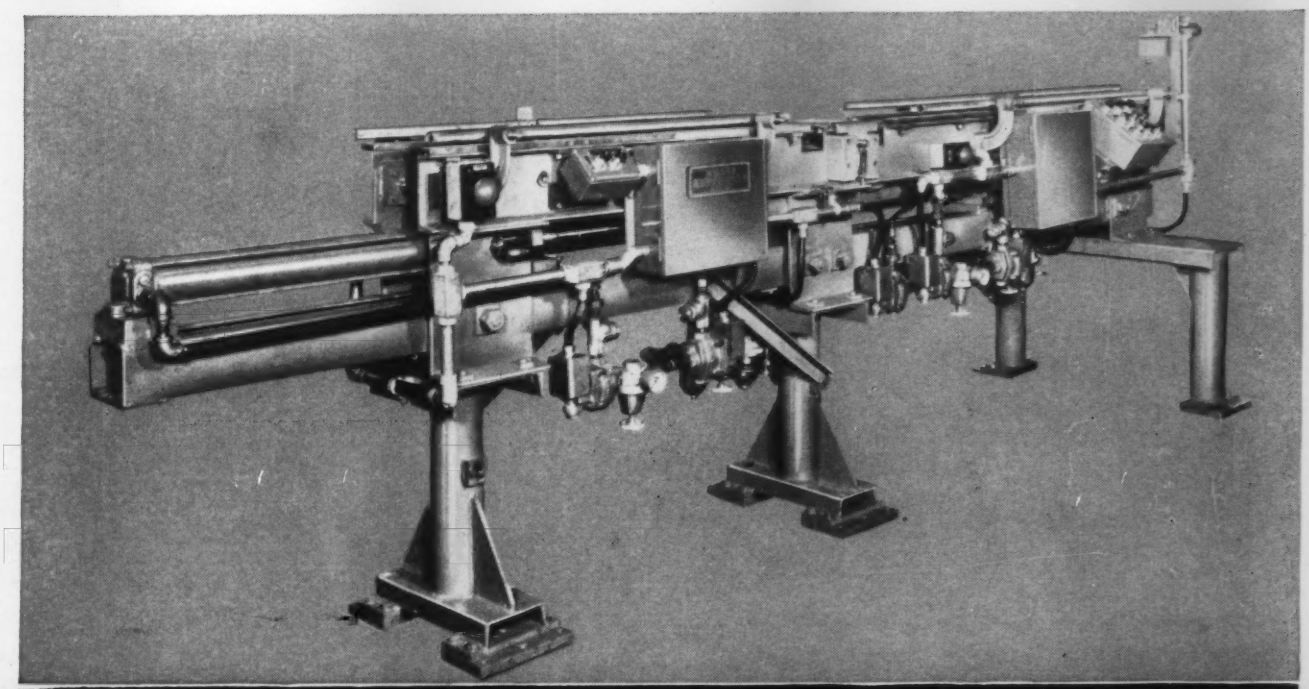
COLLET CHUCKS • FLOATING HOLDERS • TAP CHUCKS • TAP HOLDERS • AIR-OPERATED CHUCKS
EXPANDING MANDRELS • SPECIAL HOLDING FIXTURES



au'to·ma'tion: *the linear transfer of parts between automatic machines*

. . . sooner or later, you'll come to grips with automation, a production technique that relies heavily on electrically controlled air cylinders. Hannifin air cylinders and Hannifin "P-M" (electrically controlled, air-operated) valves have proved ideal for this purpose, are now in use on some of the largest automation projects.

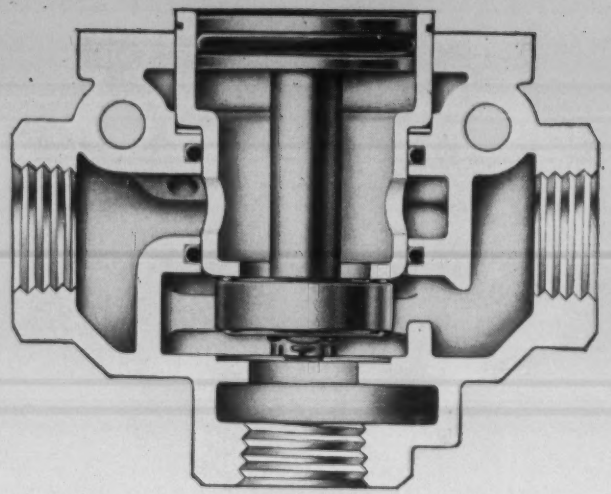
. . . our application engineers will be glad to work with your automation engineers.

HANNIFIN

Complete catalogs on Hannifin air control valves and Hannifin air and hydraulic cylinders are offered in our two-page advertisement which follows ⇨ ⇨ ⇨

HERE'S HANNIFIN'S *P-M Pilot-Master* VALVE LINE!

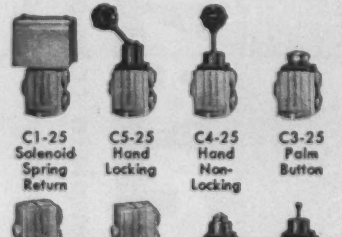
The Most Versatile Family of Valves Ever Designed and Built for the Directional Control of Air!



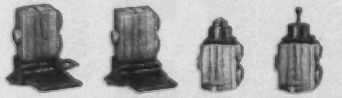
Everything you need from the simplest to the most complicated air-operated circuit can be accomplished with these valves. Included are 2-Way, 3-Way and 4-Way Master Valves and solenoid Pilot-Master Valves...direct-operated 3-Way Pilot Valves in a wide choice of operating heads...and a brand-new series of small direct-operated 4-Way valves. Plan now to get acquainted with these fast-acting, full-area control valves...there's a Hannifin representative near you who will introduce you to their many money-saving advantages.

P-M Pilot Valves

Direct-operated 3-Way ¼" (⅜" tapping optional) poppet-type valves for use as "pilot" valves for remote control of P-M Master Valves or direct control of small cylinders.



C1-25 Solenoid Spring Return — C5-25 Hand Locking — C4-25 Hand Non-Locking — C3-25 Palm Button



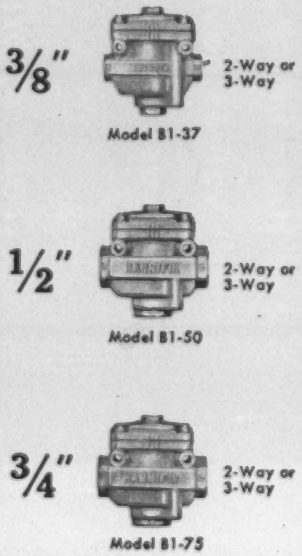
C7-25 Foot Locking — C6-25 Foot Non-Locking — C2-25 Cam Ball Type — C8-25 Toggle Operated

C9-25 Over-Riding Cam Type — C10-25 Pressure Operated — C13-25 Cam Roller Type — CS1-25 Sequence Valve

P-M Master Valves

Pressure operated

For remote control from a 3-Way P-M Pilot Valve. Series B-1, 2-Way and 3-Way; Series BB-1, 4-Way.



3/8" — 2-Way or 3-Way — Model B1-37

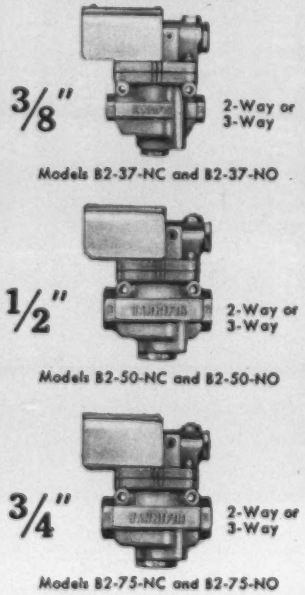
1/2" — 2-Way or 3-Way — Model B1-50

3/4" — 2-Way or 3-Way — Model B1-75

P-M Pilot-Master Valves

Solenoid-controlled by integral pilot heads...

Series B-2, 2-Way and 3-Way spring return type; Series BB-2, 4-Way spring return type.

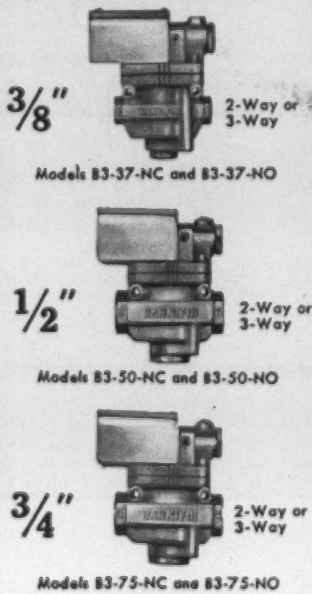


3/8" — 2-Way or 3-Way — Models B2-37-NC and B2-37-NO

1/2" — 2-Way or 3-Way — Models B2-50-NC and B2-50-NO

3/4" — 2-Way or 3-Way — Models B2-75-NC and B2-75-NO

Series B-3, 2-Way and 3-Way pressure return type; Series BB-4, 4-Way momentary contact type.



3/8" — 2-Way or 3-Way — Models B3-37-NC and B3-37-NO

1/2" — 2-Way or 3-Way — Models B3-50-NC and B3-50-NO

3/4" — 2-Way or 3-Way — Models B3-75-NC and B3-75-NO

Basic P-M Advantages

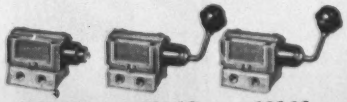
- Removable cartridge contains piston-poppet. Only moving part of main valve. Springless. Replaceable without disturbing main piping. Two cartridge sizes fit all five valve sizes.
- 2-Way and 3-Way valves operate N.O. (normally open) or N.C. (normally closed). Buy them either way or convert them on the job.
- Interchangeable: Same head fits every size valve body in any given series. Same body fits three different heads in every pipe size.
- Snap action. Speeds of 600 cycles per minute entirely practical with solenoid models.
- For any pressure from 15 to 150 p.s.i., gas or air. Higher pressures permissible when water or oil is the fluid.

P-M Direct-Operated 4-Way Valves

Direct-operated 4-Way ¼" (⅜" tapping optional) poppet-type valves for control of small double-acting cylinders.

CC1-25 Solenoid Spring Return

CC11-25 Solenoid Momentary Contact



CC2-25 Cam Ball Type

CC4-25 Hand Non-Locking

CC5-25 Hand Locking

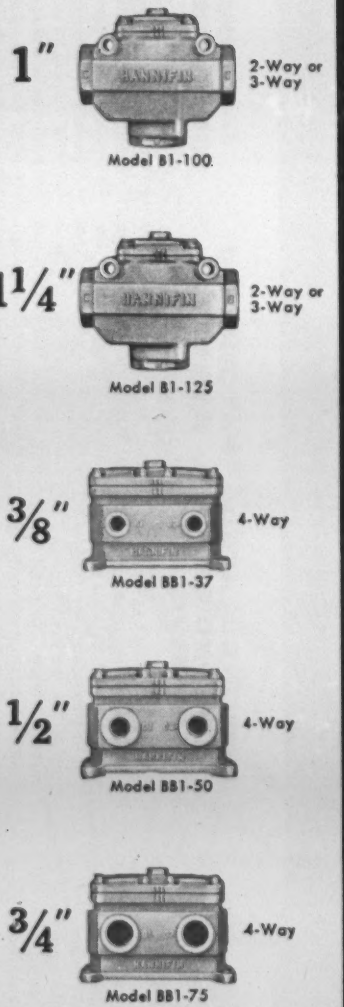
CC7-25 Foot Locking

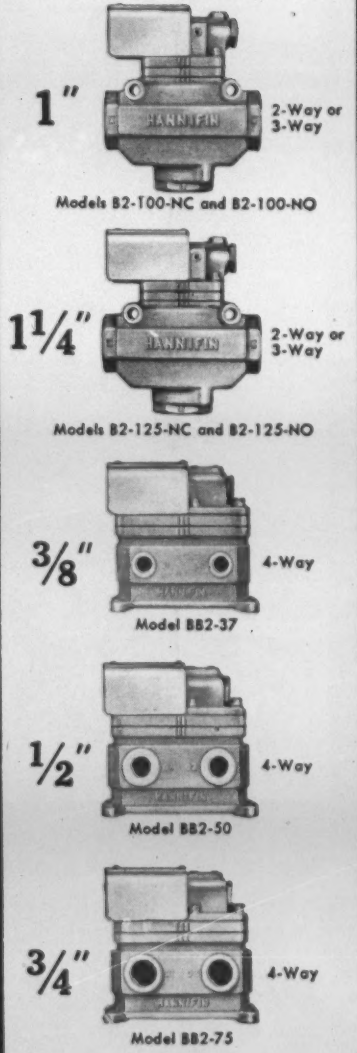
CC6-25 Foot Non-Locking

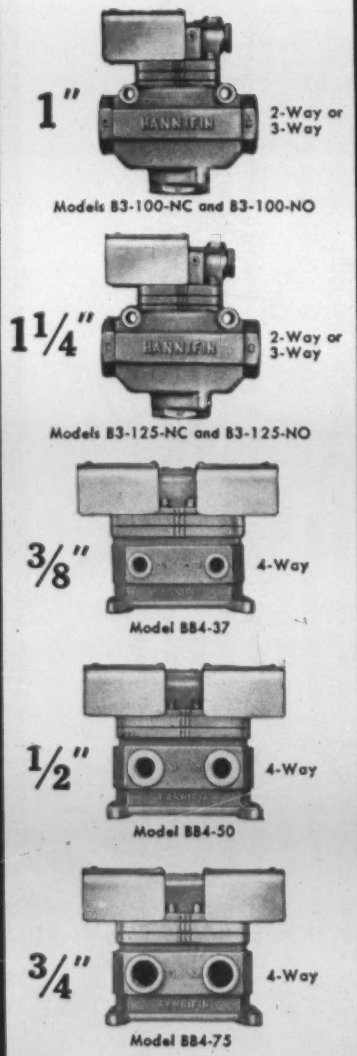
CC10-25 Pressure Operated

P-M Pilot-Master Dual 3-Way Valve

Two 3-Way Pilot-Master Valves mounted in common body. Both pilot valves and main valves pneumatically interlocked so unit "fails safe." For completely safe operation of mechanical presses. ¾" and 1¼" sizes.







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AIR CONTROL VALVES

The "P-M" valves shown here are only a portion of the complete Hannifin line of Control Valves. Write for this complete catalog.

CYLINDERS, TOO

Hannifin builds two complete lines of hydraulic cylinders and two complete lines of air cylinders.

Series "N" Hydraulic Bulletin 110

Series "H" Hydraulic Bulletin 113

Series "LW" Pneumatic Bulletin 210

Series "A" Pneumatic Bulletin 213

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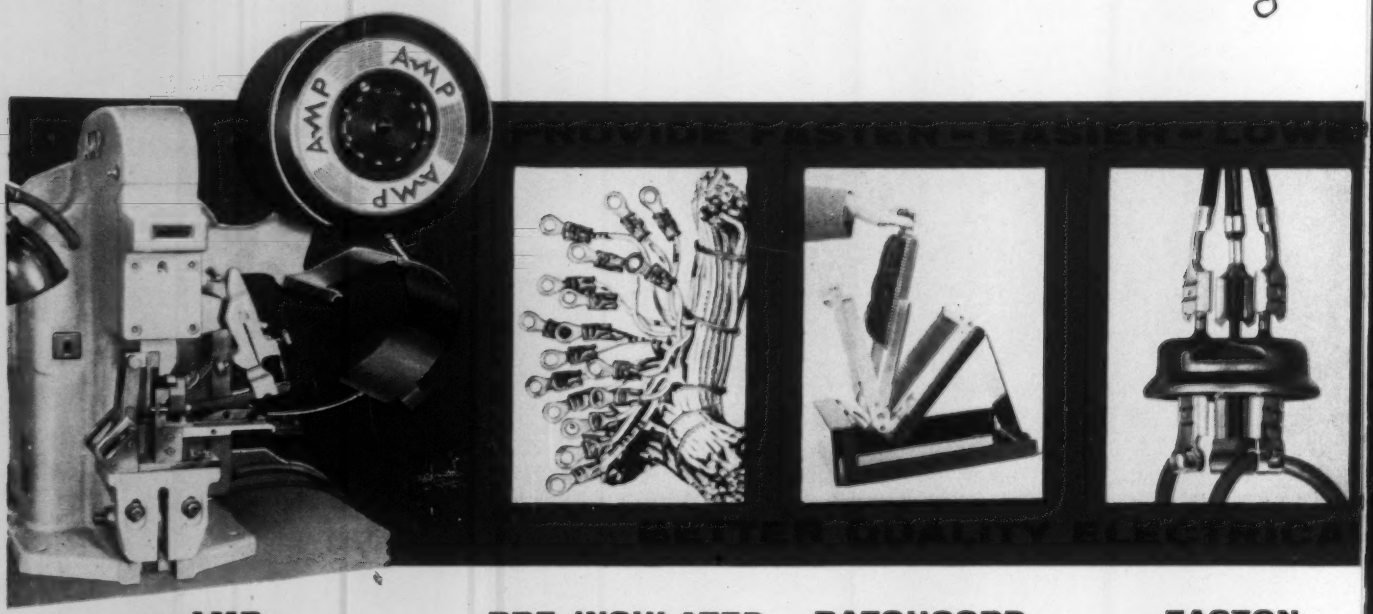
Hannifin Corporation, 1195 S. Kilbourn Ave., Chicago 24, Ill. • Air and Hydraulic Cylinders • Pneumatic and Hydraulic Presses • Riveters • Air Control Valves

Automation in Action

in wire termination AMP keeps pace with your Automation program

The AMP Automatic Wire Terminator has done more to permit high-speed wiring sub-assembly with uniformly high quality, and low cost than any other related development in the field. This is true of all AMP products, which are designed to simplify, improve, and reduce per-termination cost for all types of wiring.

Whether you connect your wires to batteries or "breadboards", control panels or power transformers, AMP's years of experience in solderless wire termination can be of service to you. As pioneers in our field, we've developed better, faster, more efficient terminations for all types of electrical products in all wire sizes from No. 26 to 600 MCM. Little wonder then, that Automation with its broad requirements of communications and control is a natural for AMP. Below are just a few of the many products we've developed to meet your requirements.



AMP AUTOMATIC WIRE TERMINATORS

Model shown above strips *AND* terminates as fast as operator can insert wires. Does both jobs with speed and precision. Standard machines crimp terminals which feed from reels. Rates have been clocked as high as 4,000 finished uniform terminations per hour.

PRE-INSULATED DIAMOND GRIP TERMINALS

AMP Pre-Insulated Diamond Grip terminals make completely insulated vibration-proof connections—ideal for standard control panel wiring. No need for costly or time-consuming separate insulating job. AMP alone offers a large size insulated terminal (wire ranges 8 to 4/0) known as Ampli-Bond and featuring insulation support and Bonded insulation.

PATCHCORD SYSTEMS

AMP's new patchcord system provides an easy way to hook up and change control wiring circuits for automatic equipment and assembly processes. New patchboard is excellent for test and inspection equipment. This is the first complete standard design Patchcord system available for universal application.

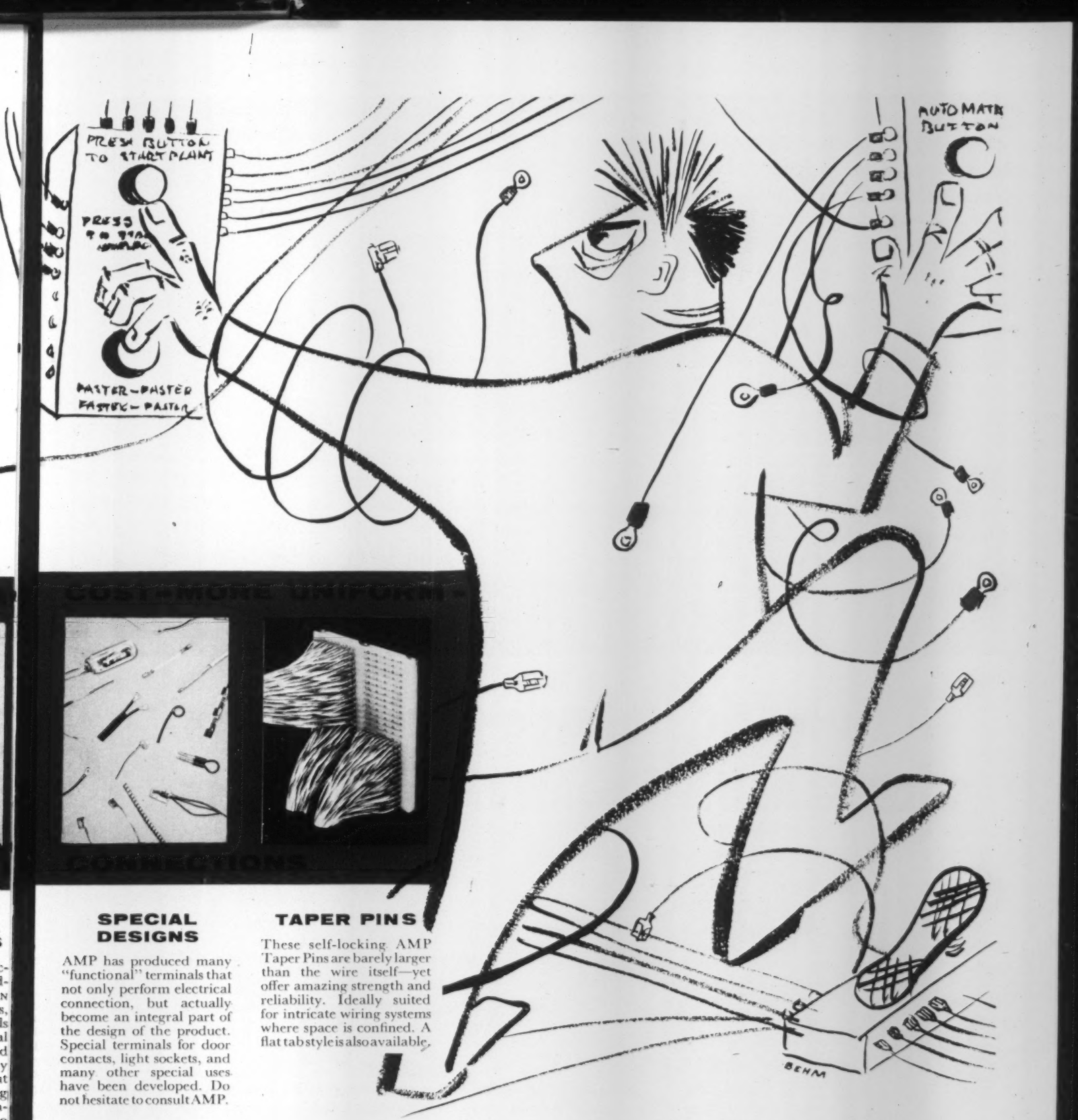
FASTON CONNECTORS

More and more manufacturers are finding the advantages of AMP Faston connectors. Timers, clocks, switches, outlets, controls—all types of electrical components when equipped with Faston tabs not only cost less to produce, but offer easier, faster wiring on the line. Faston connectors may be applied to wires at rates up to 4,000 per hour by AMP Automatic Machines.

AMP's "Creative Approach To Better Wiring"—a wiring evaluation survey without cost or obligation—is of special interest to automatic control engineers.

AMP

AMP Trade-Mark Reg. U.S. Pat. Off. ©AMP



SPECIAL DESIGNS

AMP has produced many "functional" terminals that not only perform electrical connection, but actually become an integral part of the design of the product. Special terminals for door contacts, light sockets, and many other special uses have been developed. Do not hesitate to consult AMP.

TAPER PINS

These self-locking AMP Taper Pins are barely larger than the wire itself—yet offer amazing strength and reliability. Ideally suited for intricate wiring systems where space is confined. A flat tab style is also available.

AIRCRAFT-MARINE PRODUCTS, INC.
2100 Paxton Street, Harrisburg, Pa.

IN CANADA—AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD.
1764 Avenue Road, Toronto, Ontario, Canada

Automatic voltage stabilization for sensitive control components

You can eliminate the variable of erratic line voltage on voltage-sensitive elements of automatic control equipment. Do it simply and economically with the Sola Constant Voltage Transformer.

The Sola stabilizer is a static-magnetic regulator which differs from regulators depending solely upon saturation of core materials; or electronic types employing tubes. Their characteristics, listed below, make them ideal for controlling input voltage to voltage-sensitive electronic and electrical control components.

1. Regulation within ±1%, with primary voltage (transient or continuous) variations as great as 30%.
2. Response time less than 1½ cycles.
3. No moving or wearing mechanical parts, nor vacuum tubes; requires no manual adjustments.
4. Completely automatic, continuous regulation.
5. Self-protecting against short-circuits on output.
6. Current-limiting characteristic protects load equipment.
7. Isolates the input and output circuits.

Forty-three Sola stock units are available in a wide variety of ratings, voltages and types. In addition, custom-designed units can be manufactured (in production quantities) to meet specific requirements.

The experience of the world's largest manufacturer of constant voltage transformers is available to you. We invite you to discuss your voltage stabilizing problems with a Sola Sales Engineer.

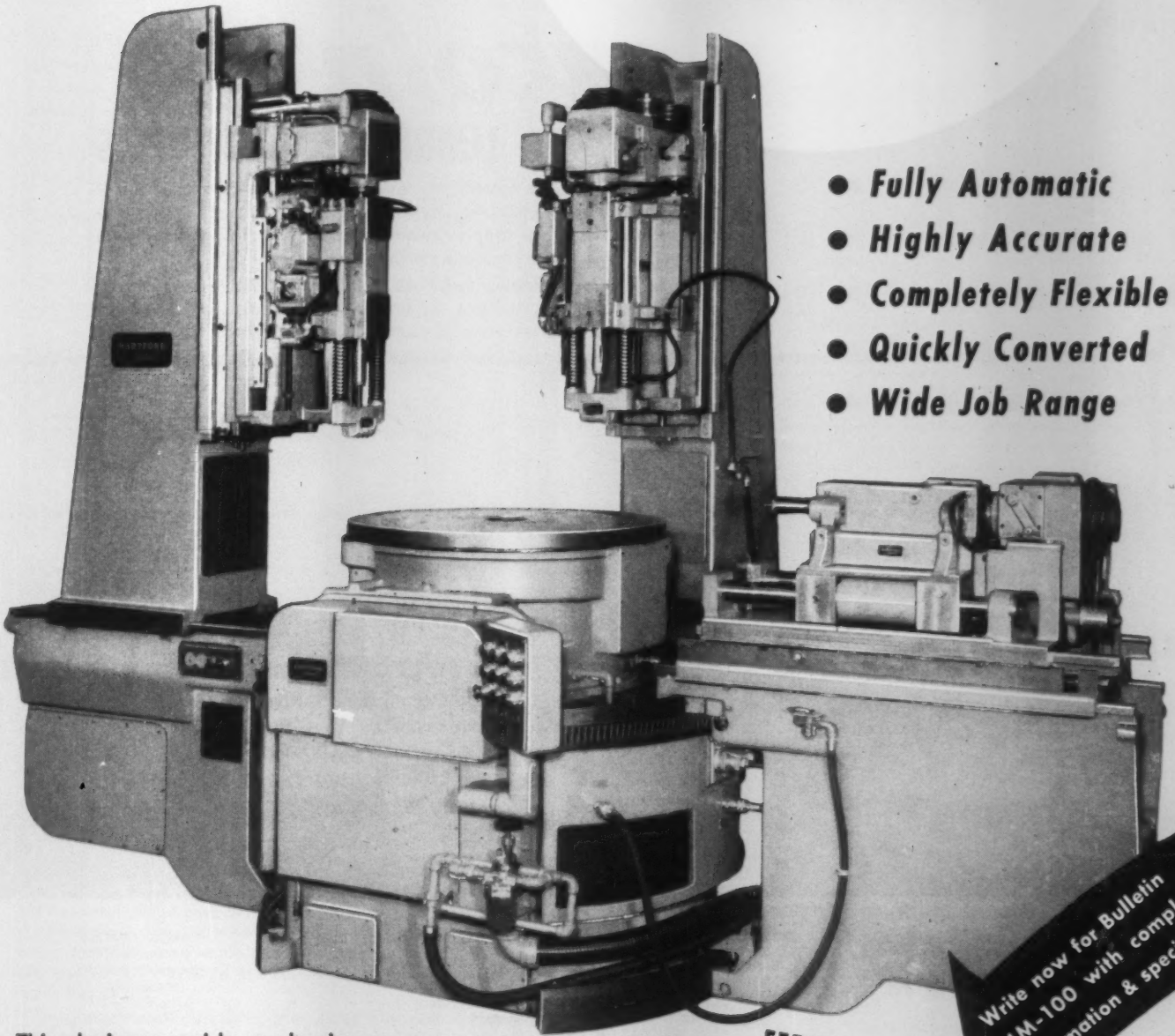
SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR LITERATURE. Sola Constant Voltage Transformers are completely described in a 24 page manual. Write for a copy of 25H-CV-200 on your letterhead, please.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts • *NEW YORK 35:* 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building • *CLEVELAND 15:* 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *Representatives in Other Principal Cities*

HARTFORD *Special*

UNIVERSAL DRILLING MACHINE



- *Fully Automatic*
- *Highly Accurate*
- *Completely Flexible*
- *Quickly Converted*
- *Wide Job Range*

This design provides a basic machine employing standardized component assemblies with utmost versatility. It enables the user to create his own single purpose machine to keep pace with engineering changes and obsolescence of parts. Yet it requires only one original investment.

QUICK SPECS:

1. Handles 8" to 60" diameter bolt circles.
2. Accommodates up to four drilling or tapping units.
3. Has 16 spindle speeds from 180 to 6700 RPM.
4. Interchangeable index plates for equal or unequal hole patterns.
5. Has ½" capacity in stainless steel.
6. Units quickly adjustable radially, vertically and circumferentially.

Write now for Bulletin UM-100 with complete information & specifications

The Hartford Special Machinery Co.
Hartford 12, Conn.

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F-1

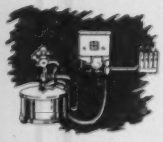
Everyone Concerned with **AUTOMATION** should know about

Lincoln
AUTOMATED LUBRICATION SYSTEMS

Automation cannot be completely effective without automatic lubrication, and Lincoln Automatic Centralized Lubricant application systems have proved that they increase output by reducing down-time to almost nothing and by reducing rejects as much as 80-95%.

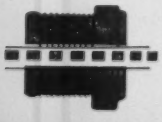
These Automated Systems fulfill *all 5* requisites for automatically applying the Right Lubricant, in the Right Quantity, at the Right Time to all bearing surfaces of automatized machines:

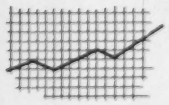
1. Assures automatic, controlled application while machines are operating to facilitate more accurate predictions of the output per time unit (day or week);



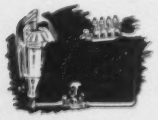
2. Permits interchangeability of machine units without changing the lubrication system on the machines;

3. Maintains a constant film of lubricant on bearing surfaces, thereby eliminating excessive wear and misalignment of moving parts responsible for a high level of rejects;





4. Helps increase machine output to a uniform maximum consistent with work done;



5. Prevents contamination of lubricant. System is sealed from lubricant supply to all points of application.

Lincoln Centralized Lubrication Systems are backed by a company with over a quarter century of experience exclusively in the design and manufacture of lubricant application equipment.

Lincoln **Automatic Centralized Lubrication can work for you!**

THESE *Lincoln* OFFICES ARE AT YOUR SERVICE

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BOSTON—H. G. Davis, Inc.	Kenmore 6-5175
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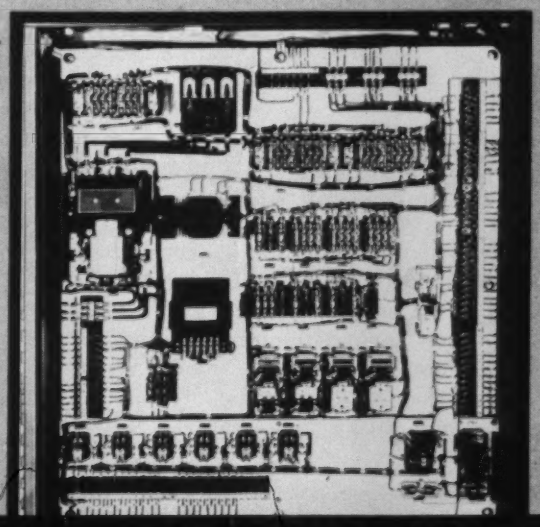
Automatically PROTECTS AUTOMATED LATHES

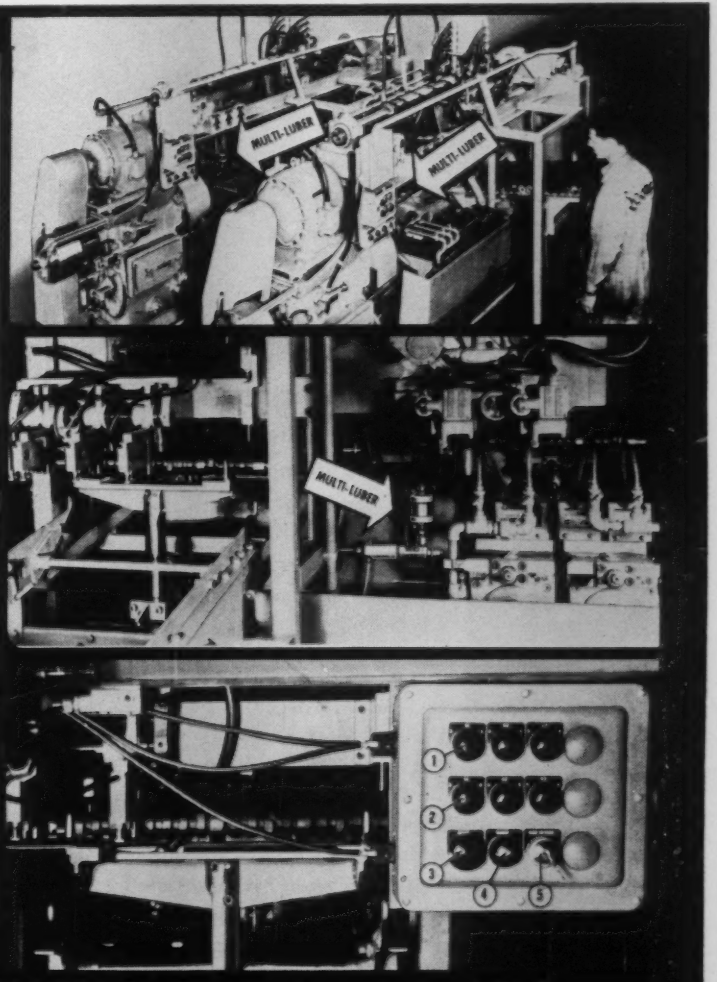
1. Two Lo-Swing lathes—equipped with Lincoln Multi-Luber automatic lubrication systems—are arranged for automatic handling of automotive camshafts.

2. Here's a close-up view of the air-operated, automatic Multi-Luber installation on one of the lathes.

3. Illustrated, Gaging Station where crankshaft dimensions are automatically indicated.

4. Shown here are the controls required for operating the two-unit automatic lathe.





Pictures show how MULTI-LUBER helps automate high precision lathes for continuous, lower cost turning operations

This automatic lathe line, turning out automotive camshafts, consists of two lathes, manufactured by Seneca Falls Machine Company, joined together by a materials-handling unit. All operations are fully automated—even to the use of an electronic quality control inspection device.

Any program of automation must have automatic lubrication to keep friction to a minimum by applying the right lubricant, in the right quantity, at the right time. Automation cannot be fully successful if inadequate and uncertain methods of hand lubrication cause burned out bearings that result in production shutdowns.

Automation can't reach its maximum efficiency when rejects run at a high level, due to misalignment of moving parts that are not properly lubricated. These problems can be eliminated with Lincoln automatic lubricant application systems.

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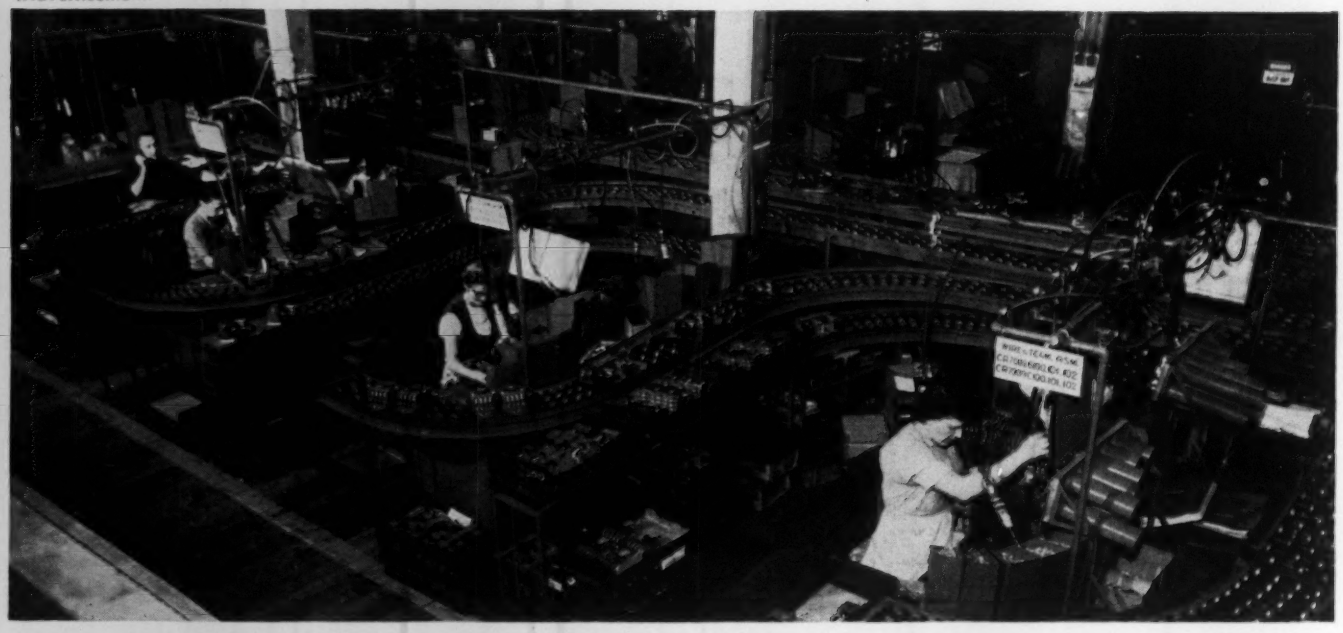


AUTOMATION OF ASSEMBLY LINES *eliminates confusion, delivers assemblies at convenient working height with minimum of waste motion, lifting and hauling. Conveyors make work* **EASIER FOR MEN . . .**

More profitable for management

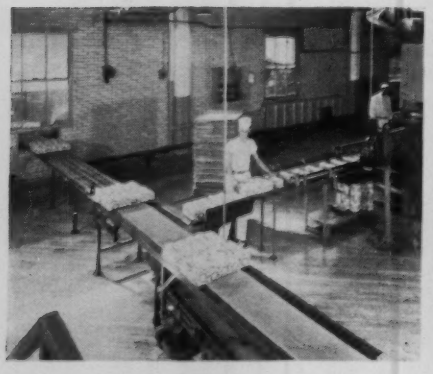
For years Rapistan has been proving the economy of controlled flow methods over old-fashioned methods of trucking, hauling and lifting. They have shown how as much as 85% can be cut from the time required to unload a box-car, using equipment costing only one-fifth as much as the equipment it replaces.

They have demonstrated how the rhythmic flow of an assembly line can replace manual methods to the profit of management, and the comfort of employees. They know how to slash the cost of packing, shipping and other materials handling operations.

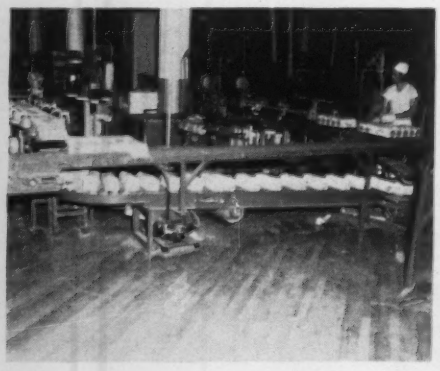
If you are interested in reducing operational costs, you should take advantage of Rapistan's free advisory service. Rapistan men have years of experience solving problems in almost every industry. Field men are backed by an extensive engineering service capable of solving the most complex problems. Rapistan is the acknowledged leader in the field, and the company is back of every Rapistan installation.

A series of field reports describes the use of conveyors in almost every line of business. Each report is a case history which tells and shows the problem, the equipment, and the results achieved. They are yours without obligation. Just tell us the industry in which you are interested. A coupon is on the next page for your convenience.

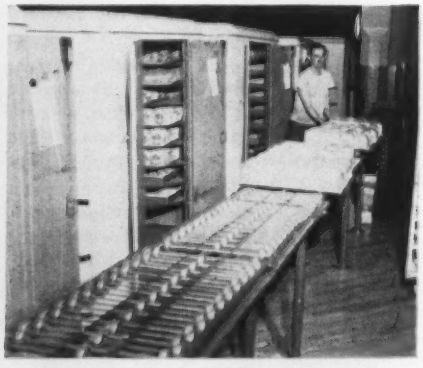
Bakery cuts loading cost



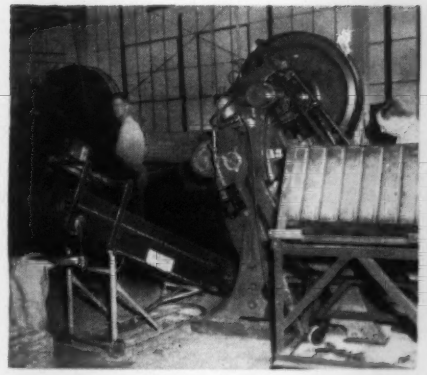
At Wonder Bread Bakery, Toledo, wrapped bread is placed on plastic trays and transferred to horizontal power conveyor.



One line from wrapper moves on upper belt to loading dock; while the other takes lower belt to semi-trailer dock.

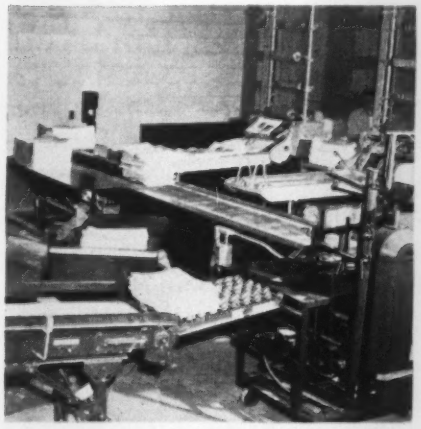


One man removes trays from gravity conveyor line, and slides them into racks inside delivery trucks. F.R. 55



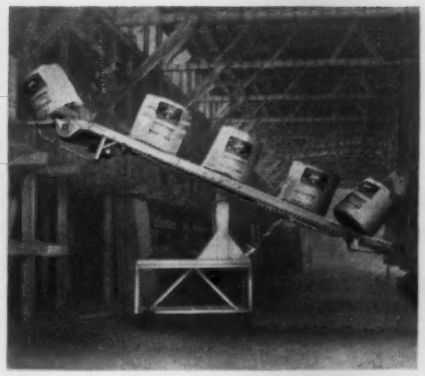
Labor savings pay cost of equipment in 19 days

At Anderson-Bolling Manufacturing Co., Grand Haven, Michigan, small stamped parts from presses dropped into tote boxes which were emptied frequently. The press was halted during these operations, cutting production time, and requiring press operators to lift two tons of stampings per day. With Rapistan Press-Veyor, men concentrate on production. Stampings are dropped directly into sacks in which they are shipped. First installation paid for itself in 19 days, and 13 more were installed. F.R. 39



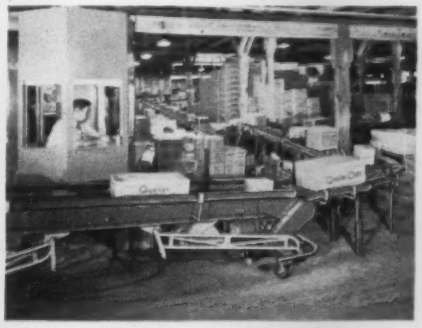
Mailing room increases production 100% with same crew

Increased output with new high-speed equipment created problems in the mailing room for The Bergen Evening Record in Hackensack, N. J. Rapistan provided a fast, efficient method of handling to keep newspapers moving out of circulation department. Mailing operation is fully automatic, papers are handled only once from press-room to delivery truck. The same crew handles double the number of papers, and Mr. Bennet, Circulation Manager says, "We can handle this increased output much faster and easier, too — no more working against the clock." F.R. 40A



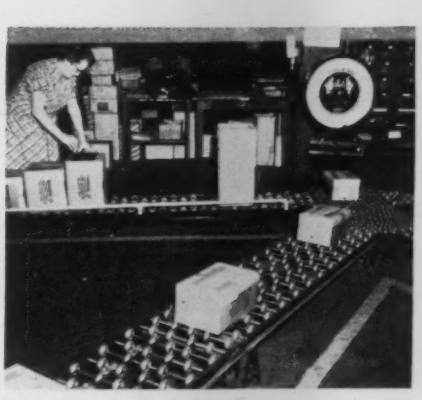
Saves 85% on unloading boxcars

Harrison Builders Supply, Oklahoma City, required 10 to 24 man-hours to unload a boxcar. After Rapistan conveyor installation, two men can unload an average car in one hour. $2,200 equipment replaces $10,000 equipment and saves eight to twenty-two hours per car unloaded. Average saving is 85% in man-hours. F.R. 2



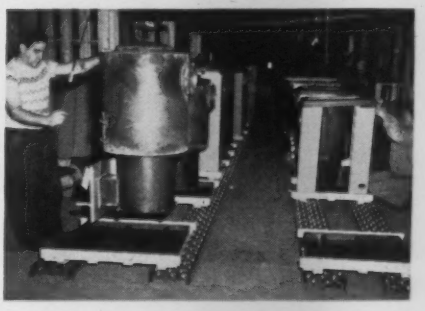
Case goods unloaded 50% faster, shipping time cut 30%

Seven Day Wholesale Grocery in Woodville, Miss. cut operating costs $600 per month with conveyorized warehouse. Stock from basement flows into main line on upper floor, joining items from first floor stacks. Checker in booth controls movement of goods from each line into outgoing trucks. F.R. 1A



Production speeded, work made easier

In a plant employing a number of women, lifting and hauling of fabricated wire products was a problem until Rapistan conveyors were installed at The Townsend Co., New Brighton, Pa. Here gravity conveyor lines from two work areas converge at a ball-transfer. After weighing, cartons can be stored on the same floor, or stenciled for immediate shipment on line 2 and then flow to shipping dock. F.R. 12A



Bulky furnaces move easily through progressive assembly

Mr. R. E. Pratt, Assistant Factory Manager, Lennox Furnace Co., Inc., Syracuse, N. Y. says, "This simple conveyor system gives us the benefits of progressive assembly methods at very low cost . . . we're well pleased with the improvement this Rapistan system has made in our product." F.R. 24A

GET THESE FIELD REPORTS

Just check the reports you wish, and mail with your letterhead to address below.

- ☐ Field Report 55
- ☐ Field Report 39
- ☐ Field Report 40A
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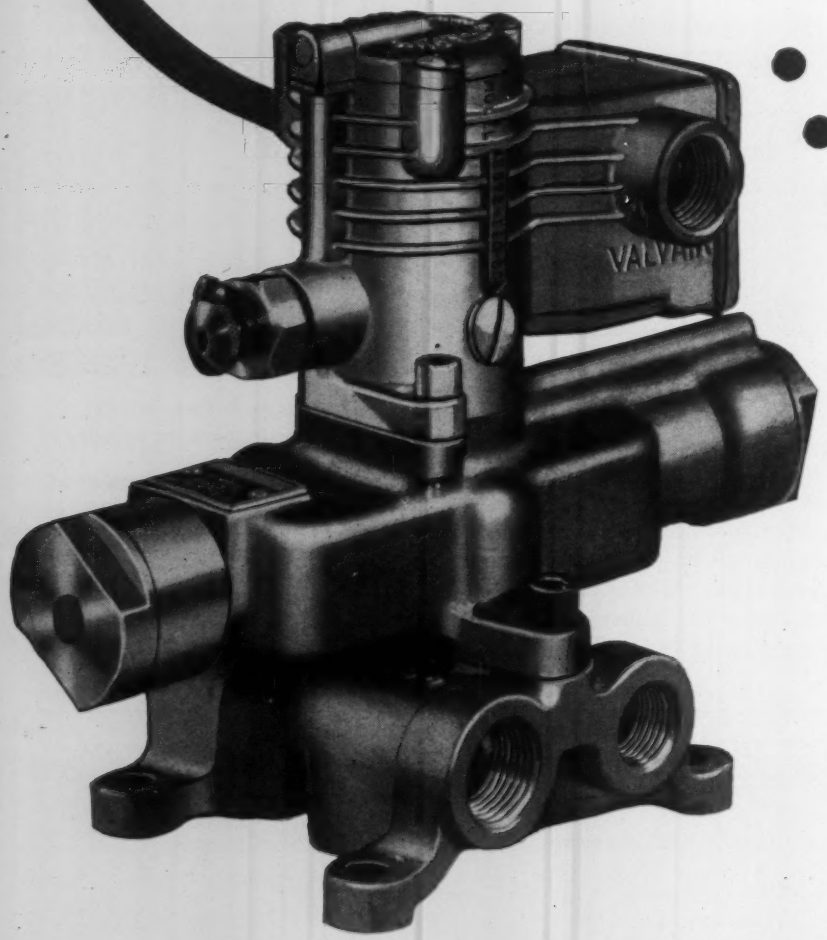

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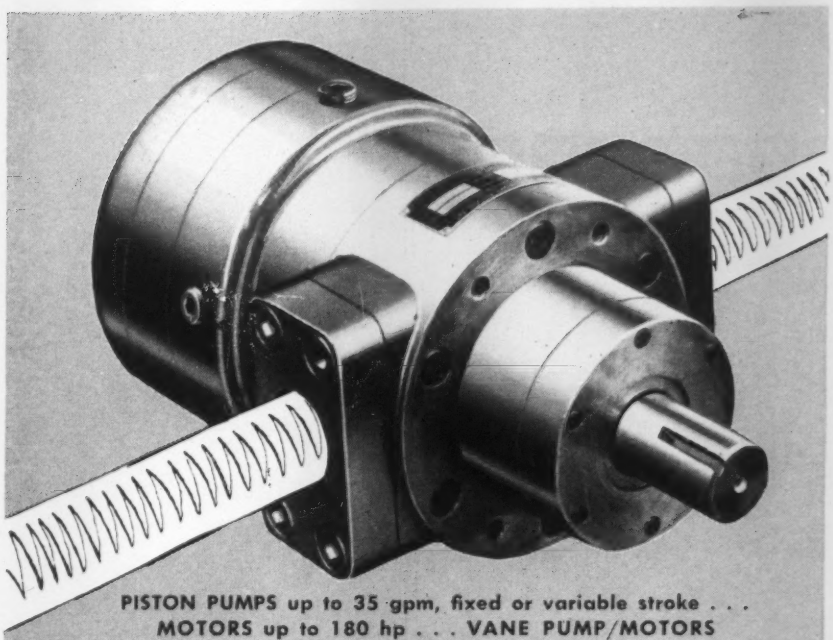

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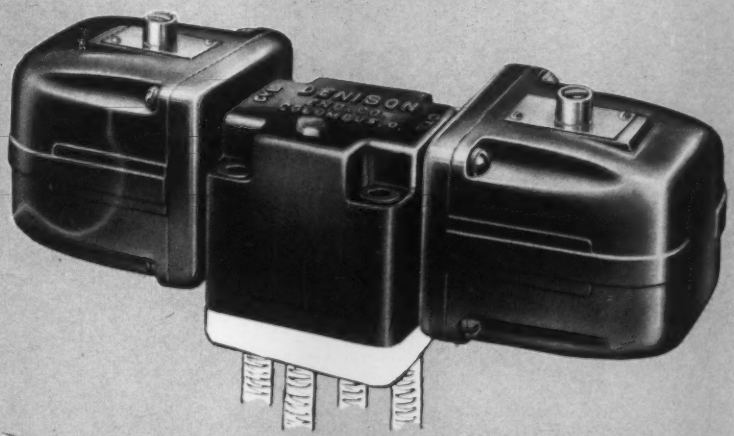

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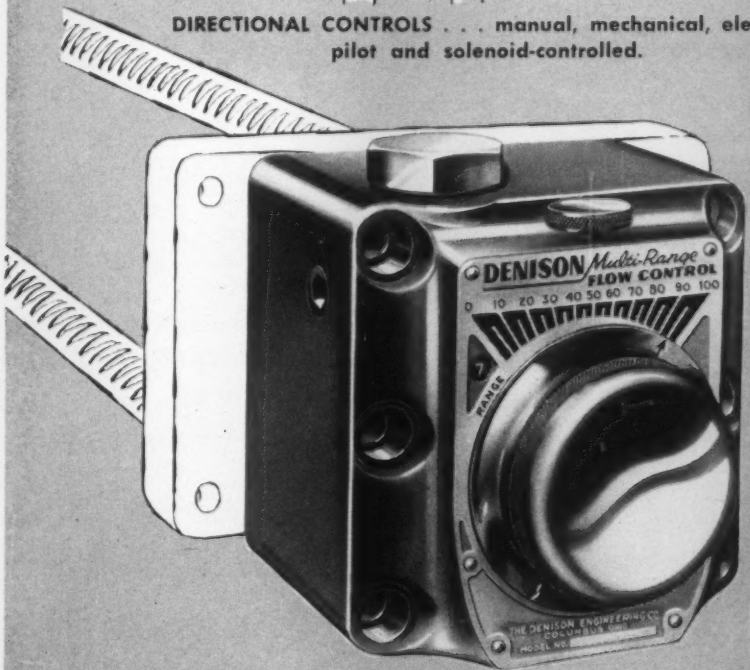

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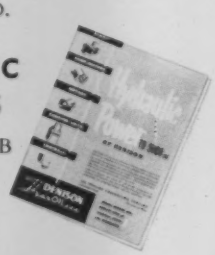

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IS A RECOGNIZED TREND

AUTOMATIC FORGING
IS ALSO A RECOGNIZED TREND

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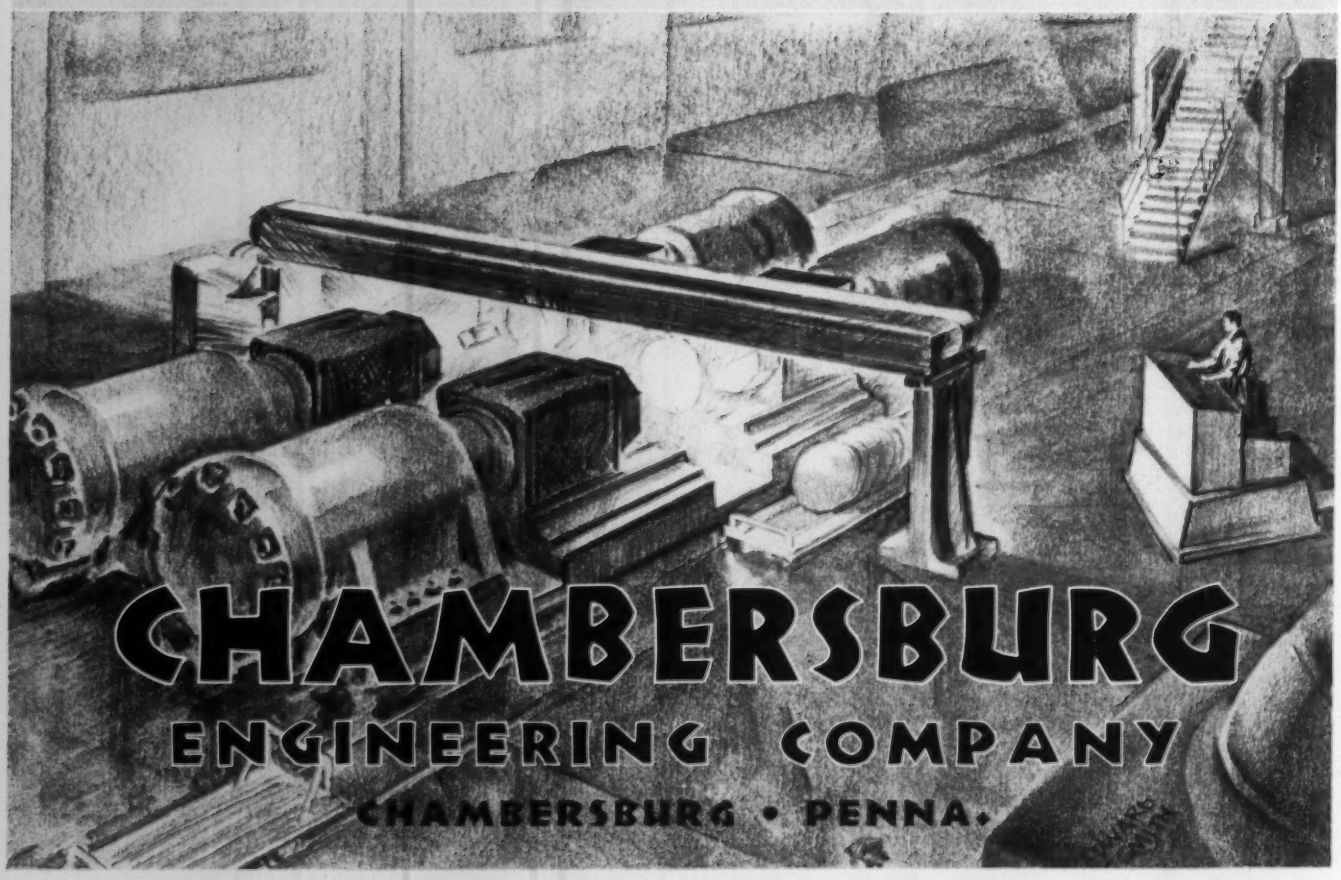

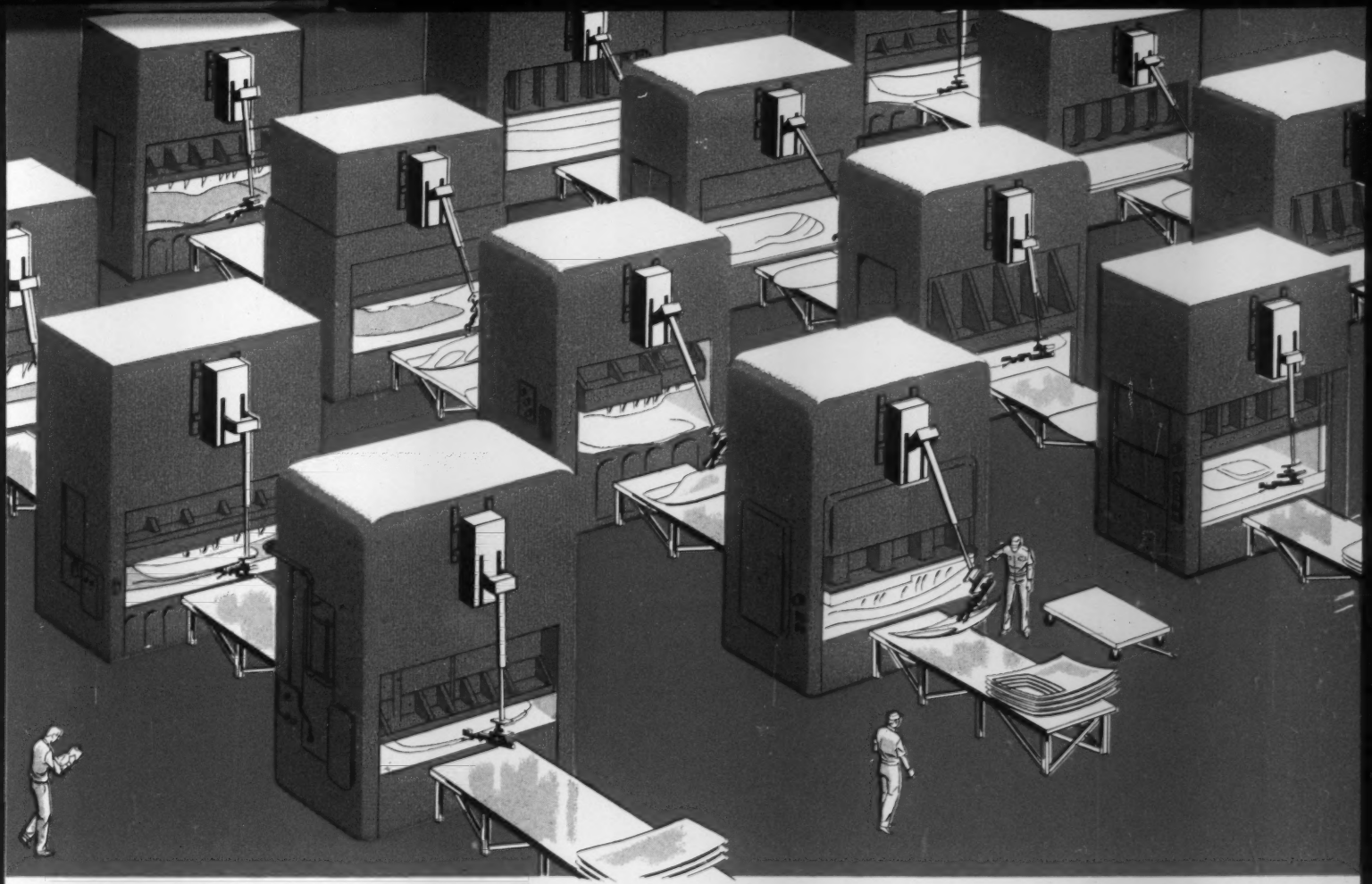

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America's top stamping plants are tooling up for automation in a really big way. Straight-flow, continuous press lines with batteries of five, six or more presses are a common sight today. And the key to virtually every continuous automated press line is the Sahlin Iron Hand—used to unload and transfer work quickly, safely and economically.

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Our latest bulletin lists prominent installations, describes operation of the Iron Hand and shows various models in actual use. Send for a copy today and give your production a helping hand—with an Iron Hand.

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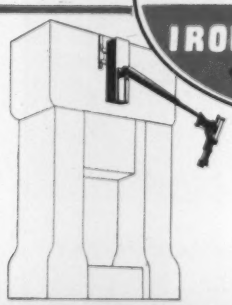

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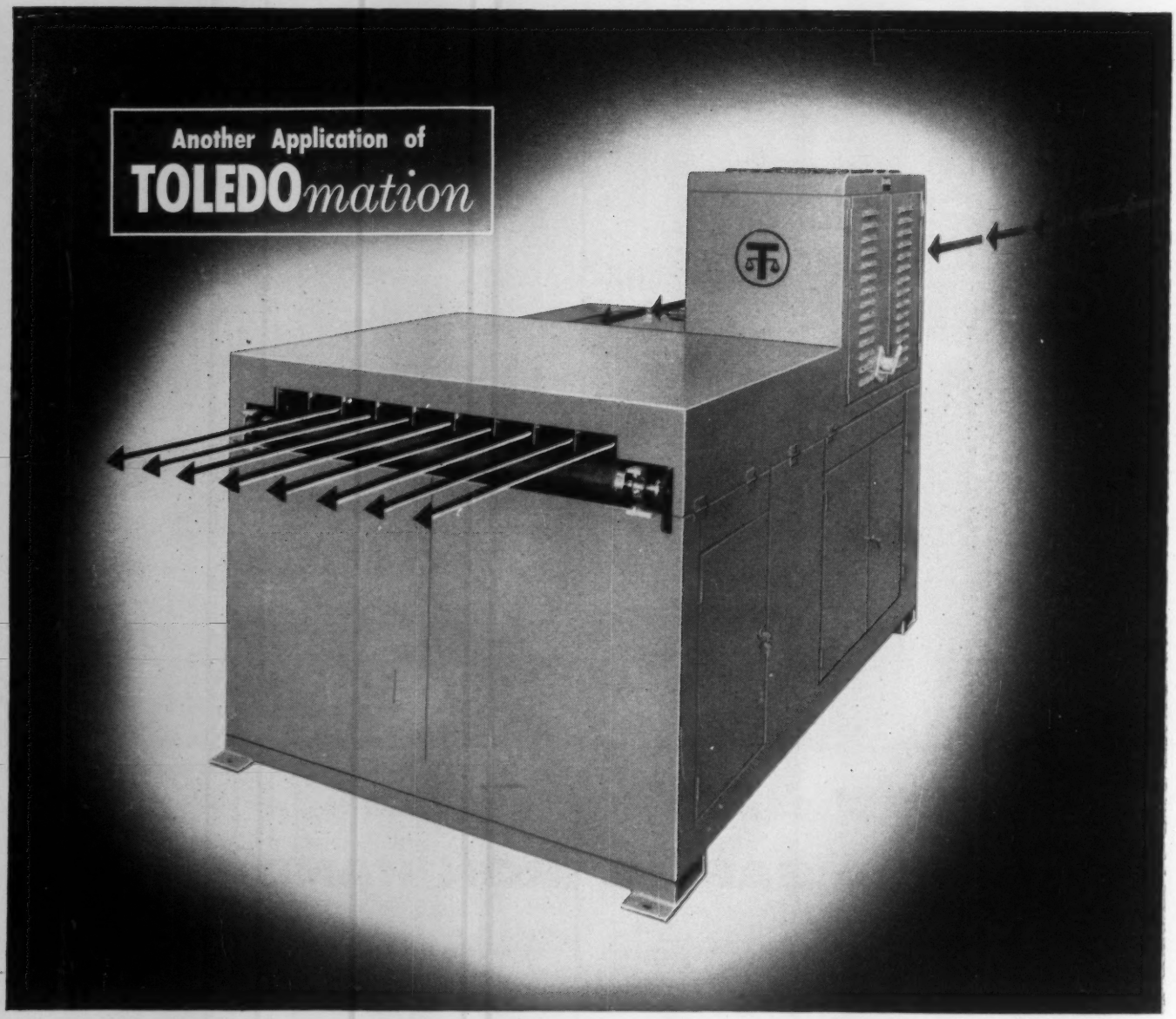

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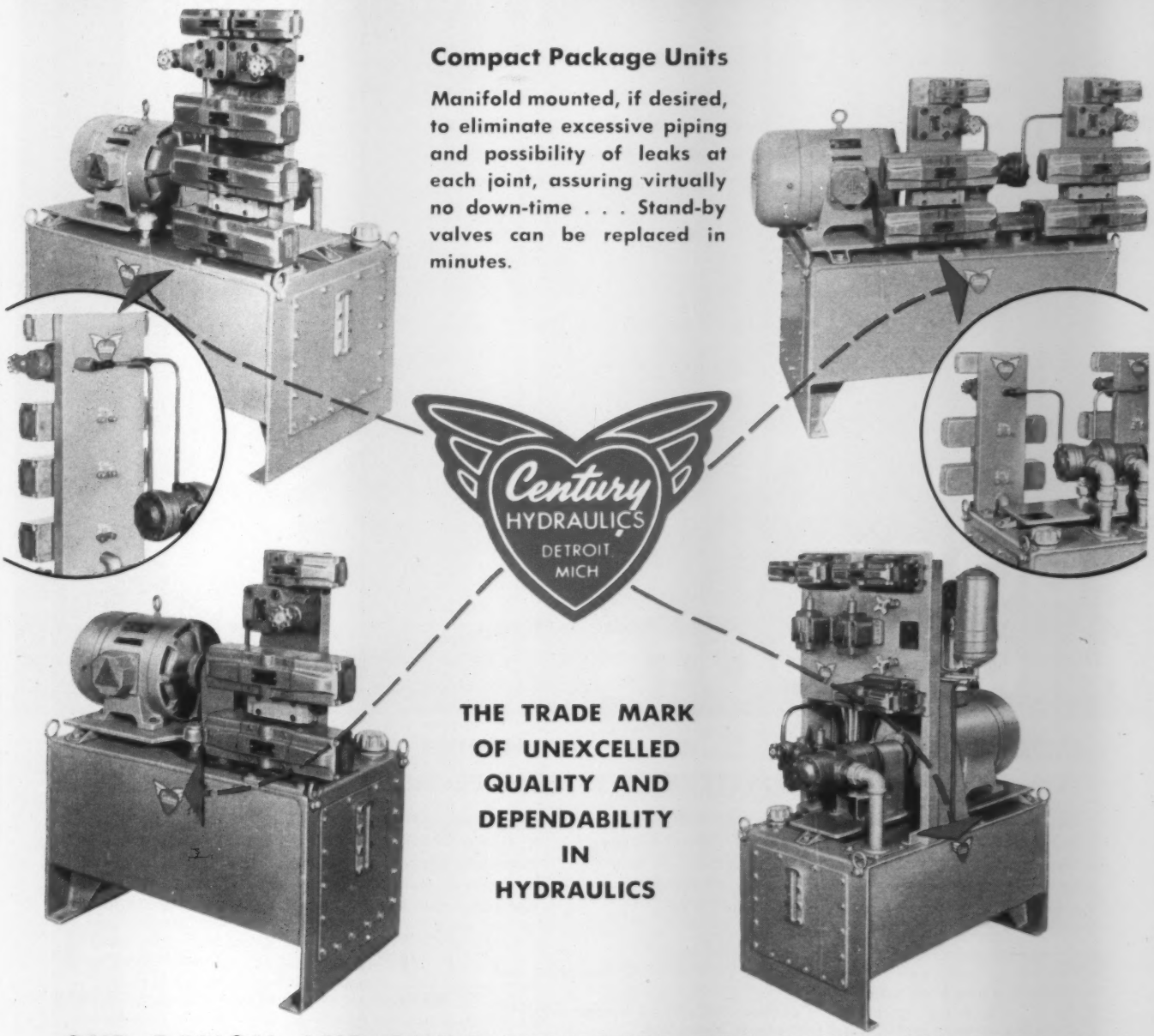

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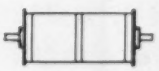
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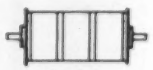
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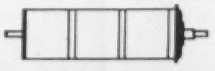
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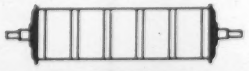
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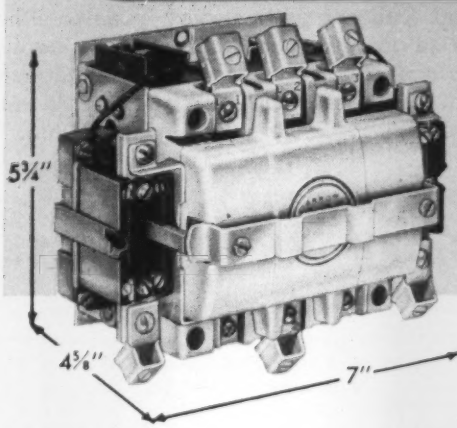

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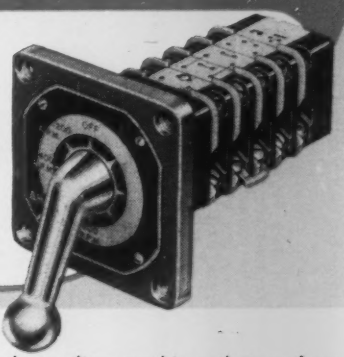

"PPS" PUSH-PULL SELECTOR SWITCH

Industry, in its march toward automation, is demanding machines that perform more functions automatically. This means that machines are becoming increasingly more complicated; the problems of space and weight are more acute than ever before. More . . . and more complicated . . . electrical controls are required, and there is less space available to accommodate them.

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1 From the railroad car, the ingredients (rubber, reclaim, etc.) move through cutters and Plasticator-Pelletizers. The pellets are cooled, insulated from sticking together and blown to collectors on the roof over the compound rooms.

2 These blenders hold and blend as much as 20,000 pounds of rubber pellets. This results in a more thorough blend than is the case with large pieces from cut rubber bales.

3 A recipe set on the control panel can be repeated 8, 10 or as many times as the schedule calls for. The weighing out, sequence delivery to internal mixer and mixing operation continues without manual attendance until the full quota of batches has been weighed and mixed.

4-8 The mixed stock moves through pelletizers, coolers and special storage facilities (reserved for various types of stocks), then into surge hoppers over an automatic mill of patented design, which will warm these stocks and feed them continuously into calenders or extruding machines. Master batch stocks can be pelletized in same machine, returned to the compound room and stored in their respective bins over automatic scales.

5 Carbon Black, in Bulk Form, moves directly from railroad car to storage bin. By automatic control, black is dispatched to any one of a number of surge hoppers over the mixers. These in turn feed automatic scales which discharge the correct weight at proper rate directly into mixing chambers.

6 Oil in bulk storage is pumped to storage facilities at the internal mixer. These storage facilities also supply automatic scales which inject proper amount of oil directly into the mixing chamber.

7 Dust from the mixing operation is collected continuously and returned to the Mixer for incorporation in the same batch from which it was originally taken.

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AUGUST 1954

Future Unlimited

Publication of AUTOMATION magazine begins auspiciously in a dynamic era. Awareness of automation and its portents has risen to an amazingly high point across all industries. Full understanding of its possibilities and advantages, its character and general application, its real effects and influences, evidences the growing need for a practical and factual journal specially devoted to management, supervision and engineering phases of automation in their broadest sense.

Although new in name, automation in various forms has been on the scene for many years. One revelation indicates the basic idea as being at least 164 years old. The steady development in the interim would suggest no basis for excitement, no dire forecasts of upheaval, no radical revolution in thinking. Rather, a studied engineering appraisal is desirable to aid in broadly furthering these basic principles whose adoption on a sound economic basis offers the most rewarding solution for future advance in the material and personal well-being of everyone.

Dedicated to service in advancing these powerful and useful concepts across all fronts—manufacturing, processing, packaging, merchandizing, and distribution of capital and consumer goods—AUTOMATION will seek to bring into sharp focus the complete and dynamic picture, cross breeding and blending the many now separate facets of this tremendous, potential field.

EDITOR

AUTOMATION
AUGUST, 1954

AUTOMATIC MACHINES AT WORK

PRESENT AND FUTURE

By PHILIP R. MARVIN
Vice President
Commonwealth Engineering Co.
Dayton, Ohio

PRODUCTIVITY is industry's key word. Profits stem from productive operations. Businessmen recognize this and concentrate on studying ways of increasing productivity. For over one hundred years engineers have been developing automatic operations to increase productivity and to offset rising costs. Today, accelerated by advances in related technological areas, applications of automatic operations are making tremendous forward strides.

In 1832, manufacturer, author, and inventor Charles Babbage saw the shadow of the automatic factory. Today, when a telephone number dialed on the East Coast connects a telephone on the West Coast and bills the subscriber placing the call in an unattended sequence of operations, the power of automation is presented in sharp focus. The same dialing operation could start a powerhouse and phase it into the transmission line or shift an automatic machine from the production of "whiggits" to "gismos." Automation today is a basic engineering science.

What is Automation?

To today's industrial executive the word automation while not unfamiliar is thought provoking. It raises questions he wants answered. What does automation mean to businessmen? What is it? What does it mean in dollars and cents? What are my competitors doing? How far away is it? What should I do next? What will its social and economic effects be? These are some of the more important questions he wants answered.

Automation is here to stay. It is rapidly advancing into industrial operations. Recognized and capitalized it is a powerful tool in achieving greater productivity and increased profits. Unrecognized it still exerts an influence, competitors advance more rapidly.

In relatively recent periods rapid advances have been made in automation because technological advances in related arts such as operations research, applied mechanics, computer development and servosystem design have given great impetus to automation. The action of a heating system illustrates an automated operation. A job, once performed by man, has been made completely automatic—man has been replaced by machines and a better, more economical operation results.

At one time when factory temperature dropped a man had to act. Now it is no longer necessary for a fireman to note the drop in temperature and increase the heat. The thermostat senses the change in temperature and turns on the heat. This thermostat is more reliable than the fireman because it has no other duties or interests to detract it—the thermostat is in every sense of the word, a specialist. As thermostat technology developed, a clock was attached and now it can control daytime and nighttime temperatures separately in accordance with specific requirements. Anticipation devices enable it to sense a sudden drop in temperature and to bring the heat on faster to prevent extreme cyclic swings.

Automation extends this type of engineering to production processes.

How Is It Accomplished?

Automation has been achieved when raw materials are met at the receiving room door by machines, when orders are received by wire or radio and processed mechanically and when finished products are loaded by machines onto other machines that take them away. On the other hand, automation also applies to single operations executed from start to finish by machines.

To accomplish complete automation four elements are essential: (1) Work performing mechanisms, (2) actuating controls, (3) computers, and (4) operating programs. Automatic operations are initiated by an operating program. This is a program expressed ultimately in mechanical or electrical symbols outlining the way in which the job is to be performed. The computer directs operatons following the programmed outline and it performs a supervisory function. The control sets the program in motion. The work performing mechanism does the job. Economics may dictate systems from the simplest starting at element 1 to one involving all elements as the ultimate.

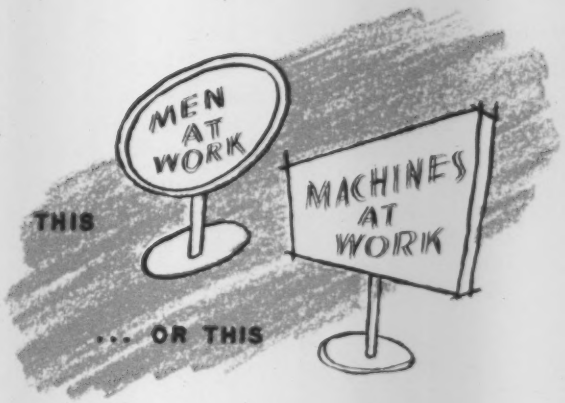
Work Performing Mechanisms

Programming for automation requires a thorough knowledge of the scope and limitations of work performing mechanisms. Since the work performing mechanism does the job, automation can't proceed beyond this ability. No matter how complicated the overall operation, it can be broken down into single functions. In the chemical industry this function might be filtering; in the electronics industry the function might be soldering. Functions are added and multiplied to form complex operations.

Development of automatic operations should stem from these simple functions. Single functions automated present the greatest versatility because the sequence of work can be varied. Time is saved by having many of these functions take place simultaneously. The designer of the automatic factory is presented the problem of determining where flexibility can be sacrificed in the interests of saving time.

The work performing mechanism is the workhorse in the automatic factory and deserves careful study. Most machines have been designed for manual or semimanual operation. Now functions must be studied and imagination exercised to develop machines that don't have the limitations inherent when man is the operator. This opens up broad new vistas to the chemical, electrical, and mechanical engineer. The objective is not to apply the tools we have but to develop the tools we need. This is a fundamental concept that must occupy a position ahead of every other one in sound thinking.

Automation's greatest limitation is found in the ability of machines to perform simple functions satisfactorily. It is easier to make a punching



What is automation?

Machines take over men's routine jobs.

How is it accomplished?

Routine jobs are programmed and machines, not men, follow sequential operations.

What does automation mean in dollars and cents?

Machines do a better job at lower cost.

What are competitors doing?

Many are taking full advantage of automation to advance their industry position and profits.

How far away is it?

It isn't, it's here.

What should I do next?

Investigate and take advantage of automation wherever feasible to improve profit ratios.

What will its social and economic effects be?

It will upgrade the workman and produce more goods for more people at lower cost with free time dividends for everyone.

operation fully automatic than to improve the tolerances in the punched hole.

A fresh look at work performing mechanisms must be taken by the designer approaching automation programs. These work performing mechanisms must be designed to take advantage of a new freedom of operation that can exist where man is not present to limit the performance of machines.

What Does It Mean in Dollars and Cents?

In many jobs machines do better work than men accompanied by greater performance reliability and at lower cost. In specific cases one or all of these factors justify automation.

Men and machines have individual characteristics; specific strengths and weaknesses appear. To be profitably employed, optimum working characteristics must be recognized. Man as a working unit has not been too well understood by his employer. Many take an unrealistic view of human performance. Man is pictured working hard at difficult tasks requiring tremendous application of creative ability and judgment.

This picture does not gain the support of operations analysts. Man's job is often a "paper pushing" or "material pushing" job; a series of mechanical sorting, comparing, and like routine operations following detailed instructions closely for high performance and often following these instructions loosely with resulting low performance.

Operations analysts recognize man's role to be highly mechanical but man's reliability is not too good. He isn't the equal of a machine. In performing mechanical operations machines are superior to men.

Man's versatility on the other hand is outstanding. Depending upon his knowledge, skill, experience and capacity, men can be shifted to a wide variety of operations as necessary.

Machines too can be shifted in their performance from one task to another but shifts are costly. Man can spend 99 per cent of his time on one operation and 1 per cent of his time on another without substantially affecting the investment but a machine might well represent as much added investment for the 1 per cent task as was represented by the investment for the 99 per cent task. Performance versatility requirements must be recognized in considering automation.

Primarily, operations analysts studying human performance find man's jobs have two common characteristics. First, they are routine in nature. Second, they are varied. The first characteristic lends itself easily to automation, the second less easily.

To the extent that man is called upon to exercise genuine creative talent, human performance is supreme. The unequivocal statement can be made that creative talents can't be automatized. But the operations analyst doesn't find man actually called upon for creative ability in manufacturing operations. The analyst is willing to go further and say that man's creative desire is a troublesome factor when man acts on the basis of creative ability in lieu of following instructions.

Recognizing that machines can't substitute for creative ability the operations analyst might even consider that this was a very real asset accruing to the machine. Machines operate according to instructions.

If the job calls for typing telephone invoices, assembling automobiles, fastening tube sockets in a television chassis or controlling the fermentation time of a malt liquor, it is important to know that the job is being performed. Machines give this assurance.

The economic aspects of this bring such a variety of cost factors to bear in automatic operations that no general data are significant. One figure that is quite revealing, however, is the amount of money represented by a rate of $3 per hour over a 24-hour period in the course of a year. A machine working such a schedule would have a yearly take-home pay of $26,280 and in the course of a conservative twenty-year life this machine would earn over half a million dollars if it took the place of only one man per shift.

Businessmen recognize that where automatic equipment can be utilized, sizable investments are justified by the economics of automation.

How Does It Affect Competition?

As competition increases, industry is trending toward automation. Businessmen must make an independent appraisal of the nature and importance of developments in individual lines of activity. Development and application of automatic equipment is exerting a major force in a rapidly increasing number of industries. Failure to become familiar with the nature of competitors' activities has resulted in disaster.

Obviously competitors who install automatic equipment resulting in lower costs have two courses open to them in formulating price policies. They can maintain prices with larger profit margins or they can lower prices, increaase volume and profits too. Either course over time is an industry threat. Those in the know will grow, profits will be stabilized and increased industry position will be improved.

How Far Away Is It?

Development of automatic operations has been in progress for years. Each year witnesses greater strides in the direction of fully automatic operations. In the last ten years tremendous advances were made. The next ten years should see even

greater advances made in the application of automatic equipment. Today's drawing boards point in this direction.

What Should I Do Next?

Practical considerations of automation direct executive attention to carefully conducted operations analysis in developing manufacturing programs. Too much emphasis cannot be placed on the need to know what operations must be performed, the nature of the raw material to be fed into these operations and the exact specifications of the required product.

What Operations Should Be First?

Specific factors should be studied in determining where thinking about automation should start. These factors are:

1. Costs.
2. Quality of performance.
3. Intricacy of operations.
4. Reliability.
5. Hazards inherent in operations.
6. Availability of personnel in quantity needed, when needed and where needed.

Any one of these might justify installation of automatic operations. Where labor costs are high, automatic operations appear most attractive. Where hazards to workmen exist, automation should be given top priority. Intricate operations performed by machines eliminate training problems. Reliability is assured by machines. Personnel shortages caused by lack of people, unpopularity of off-hour shifts and vacation-time are solved by automation.

Mass-production operations as a general rule come first. Most of our technological advancements have come first in volume production industries. This has been true in the metals industries, the chemical industry, and the electrical industry.

The trend is established not only in basic industry groups but in retailing too. Items such as merchandise, groceries, tickets, and postage stamps are being sold by machines instead of clerks. Office operations too are undergoing a revolution along with the automation of manufacturing operations.

Social and Economic Effects

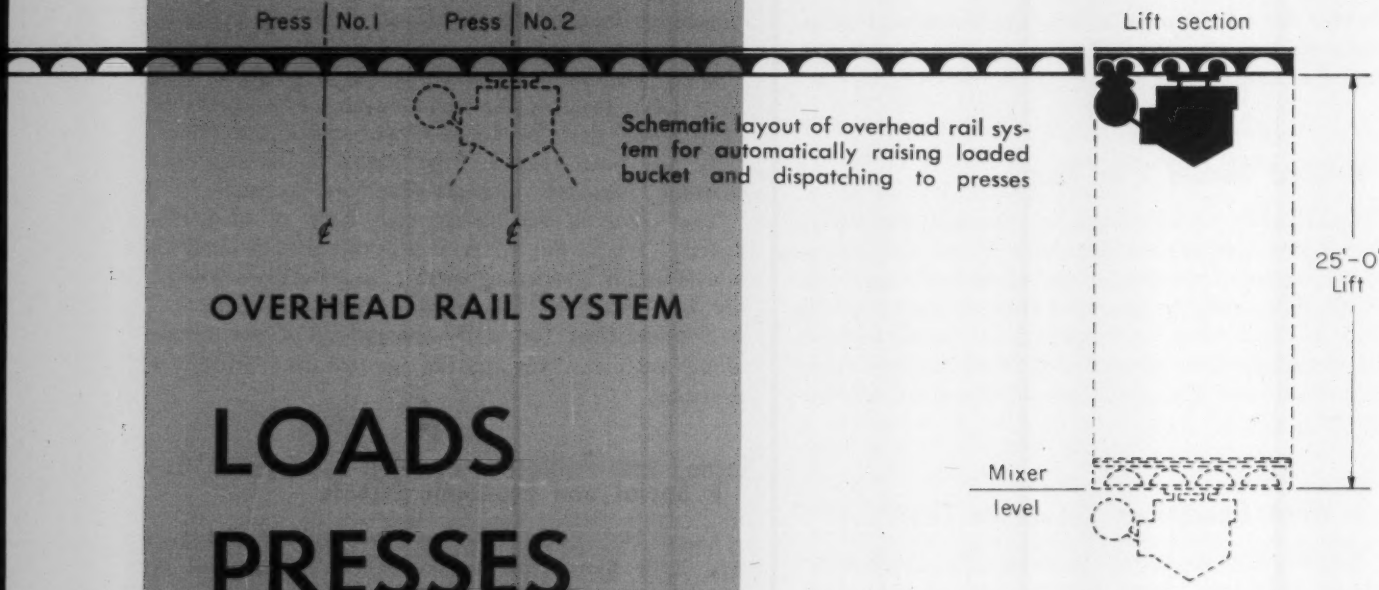
Goods will become better and cheaper and men will have more time to enjoy life. These will be results on a broad scale. On the negative side there will be upheavals in industries where the impact of automation was not adequately appraised in advance, accompanied by adequate planning. Some businesses will grow and some will disappear.

This is normal in a competitive economy. It stresses the need for farsighted planning, research and engineering—but these are not specialized requirements resulting from a trend to automation. Planning, research and engineering are the life blood of any healthy industrial operation in today's competitive economic environment. Planning, research and engineering along with automation are management tools for creating stability, growth, and profits. Industry has entered the era of automation. Successful management groups will capitalize on automation.

THE AUTHOR

PHILIP R. MARVIN has served for a number of years as a consultant on both industrial and Defense Dept. assignments and has been actively associated with the Atomic Energy Program. He was a member of the research department of General Electric until World War II when he organized and managed the chemical and metallurgical department of the Bendix Aviation Marine Div. Following the war he was director of research and development for the Milwaukee Gas Specialty Co. before joining Commonwealth.

Although his activities are primarily concerned with management problems, Dr. Marvin's work on automatic processing equipment, servo controls for aircraft and fully automatic machine tools have given him a keen insight into the automation picture today. He holds a number of patents on electric control devices. A registered engineer in five states, he has degrees in both engineering and business.

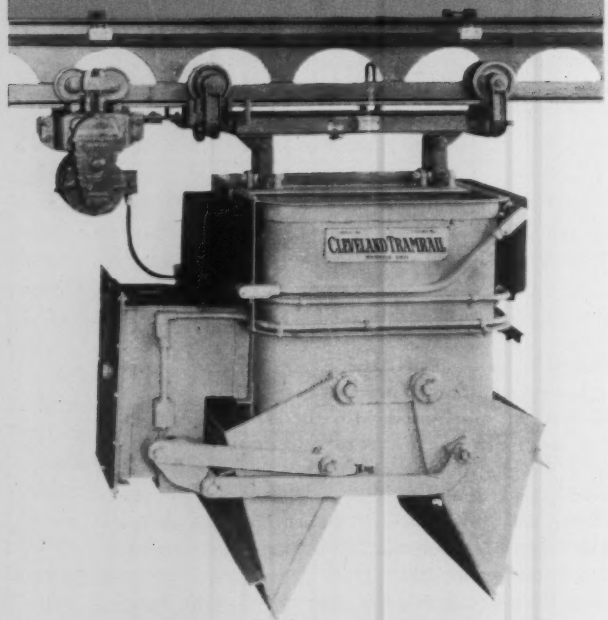


Schematic layout of overhead rail system for automatically raising loaded bucket and dispatching to presses

OVERHEAD RAIL SYSTEM

LOADS PRESSES

Power conveying arrangement elevates and dispatches clay batches to presses by push-button control



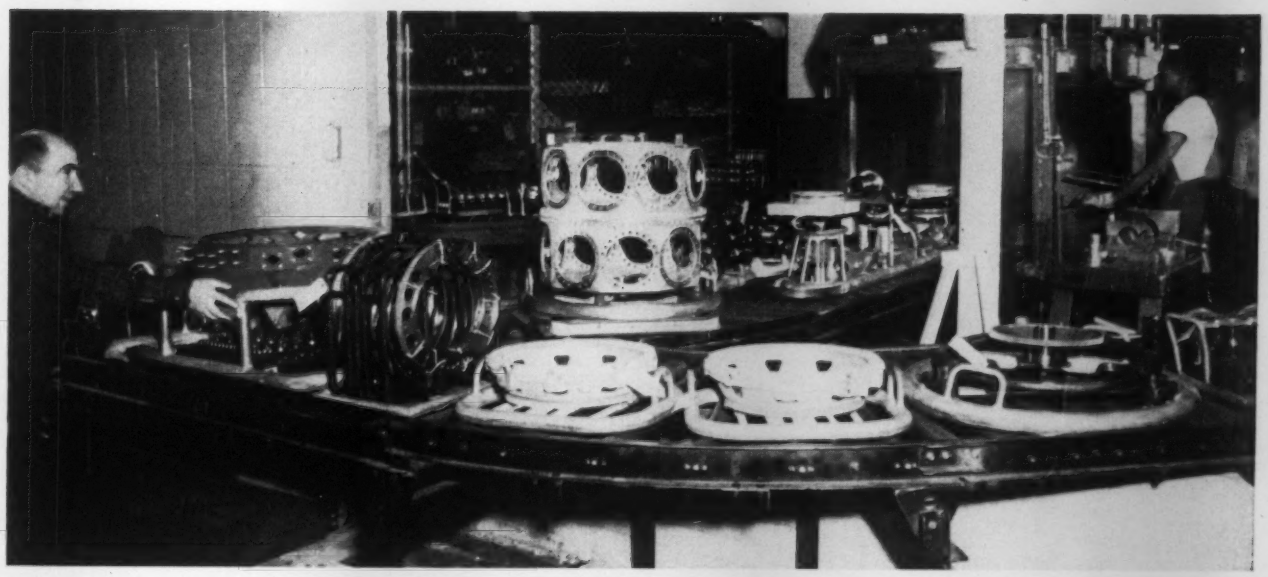
Automatic tractor driven bucket for clay batch handling showing power operated split hinged gate

TRAVELING BUCKET for handling dry granulated or lump materials and moist mixtures, developed by the Cleveland Tramrail Div. of Cleveland Crane & Engineering Co., automatically dispatches loads of damp clay batch from a mixer to one of two presses.

Designed around an overhead track and crane system, the bucket carrier is powered by a tractor drive and has a travel route including a lift of 25 feet. The 2000-pound, 22.5 cubic foot bucket is operated by an enclosed motor and has a split-hinged gate with an unusually wide opening for discharge of slow moving, tacky materials, left.

Cycle of operation for this particular system is as follows: (1) Clay batch is poured into bucket at mixer at low elevation; (2) mixer operator presses pushbutton and track section with bucket carrier is elevated 25 feet. In high position, track section interlocks with overhead track system and bucket carrier remains here until called for; (3) when batch is needed at either No. 1 or No. 2 press, the press operator presses corresponding pushbutton. This causes the bucket to advance to the proper press and without further attention of the operator it discharges its load and returns to the mixer, as illustrated above.

Traveling buckets of many types and sizes have been developed for various materials. The track systems on which they operate have been provided with a wide variety of control methods enabling nearly every conceivable kind of materials handling operation to be automated. Cycles may be semiautomatic or completely automatic, depending on the production circumstances and economics of the operation. Regardless of the particular character of the material which must be handled in process—solids in any form or consistency, fluids and separate pieces or products—full automation necessitates careful co-ordination of this key function of handling.



1 Protective-coated pallets carry engine parts by roller conveyors to the wash booths where the parts are oil-sprayed clean prior to being sent to the assembly area. Each engine requires 50 pallets for assembly and approximately 60 feet of conveyor line.

AUTOMATION TODAY

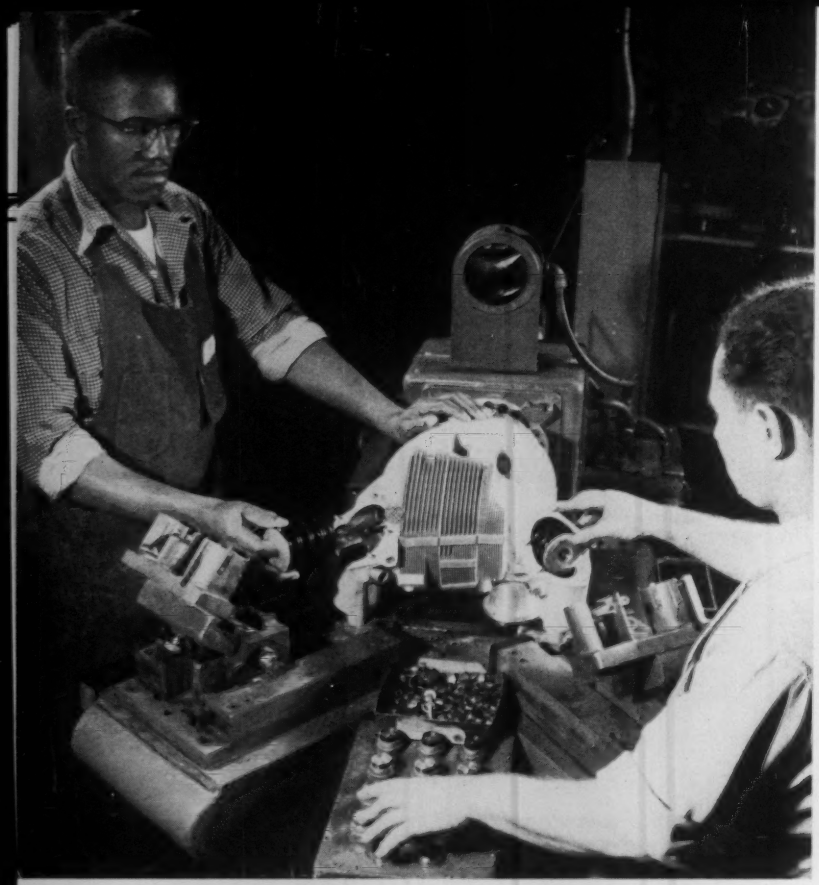
LINE ASSEMBLES AIRCRAFT ENGINES

FIRST PROGRESSIVE automated assembly line in aviation engine history—one that can increase production capacity by 250 per cent—has been placed in operation at the Wright Aeronautical Div. of the Curtiss-Wright Corp. This new line, which makes extensive use of automatic machinery, is now building various models of Turbo Compound engines for 22 of the world's leading airlines and for a substantial number of military planes as well. The line can be later adapted to newer and more powerful versions of the same powerplant and, despite greatly increased capacity, the new line takes 42 percent less space than the former assembly line.

Automatic machines, especially designed and built to order for the installation, do everything from assembling a complete crankshaft to tightening bolts and crimping fasteners. The new line was designed to meet several requirements: (1) Ability to make engines in greater quantities without the need for additional plant space, (2) ability to build engines quickly and more efficiently —some of the automation equipment now in use is up to 500 precent faster than the best hand work on an identical operation, and (3) maintenance of the highest standards of quality—this fast working equipment is superior in precision to the most highly skilled workmen and the finest gages.

One of the underlying principles of the line is the division of the engine into three major sub-assemblies: front, power, and rear sections. As each of these units is completed, it is mounted on an appropriate flow rig that washes it down for cleanliness, checks its oil flow, and (in every case except one) rotates all working parts to make certain that they move freely.

All new Turbo Compounds are assembled in



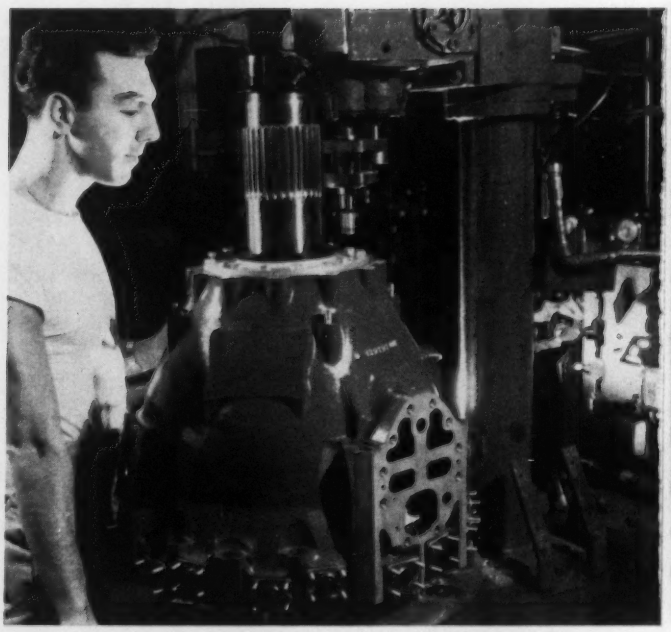
2 This cylinder machine assembles the inner parts for each of the 18 cylinders of Curtiss-Wright Turbo Compound. The machine locks the springs into place and then is reset to depress the spring so that the rocker arm can be dropped in.

3 This automatic torque and assembly machine, one of many designed for mass-production of the engines, tightens the bolts of master rods.

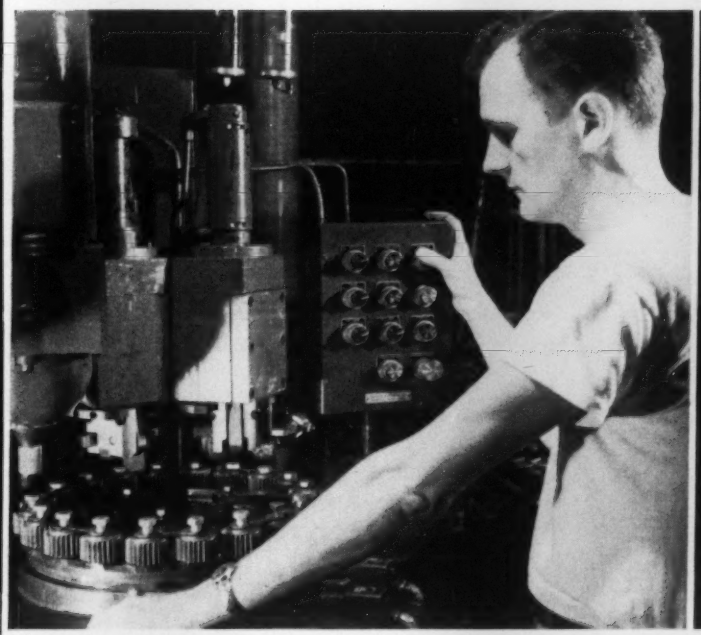
what is called the *green line*. Once completed they are mounted on a preoil rig that gives one final check on the accuracy of the assembly process. Then the engine is washed in a spray house and mounted in a test cell where it runs for approximately four and one-half hours under a routine that simulates conditions of flight operation.

Back from test, the engine is disassembled, parts are washed in spray booths, and all pieces are inspected. The engine is reassembled on another automated line—called the *final line*—that is an exact duplicate of the *green line*.

Once more the completed engine is washed and tested, although the final run lasts only three and one-half hours. Only then, twice proved in the test house, is an engine accepted and sent to the packing room for shipment.

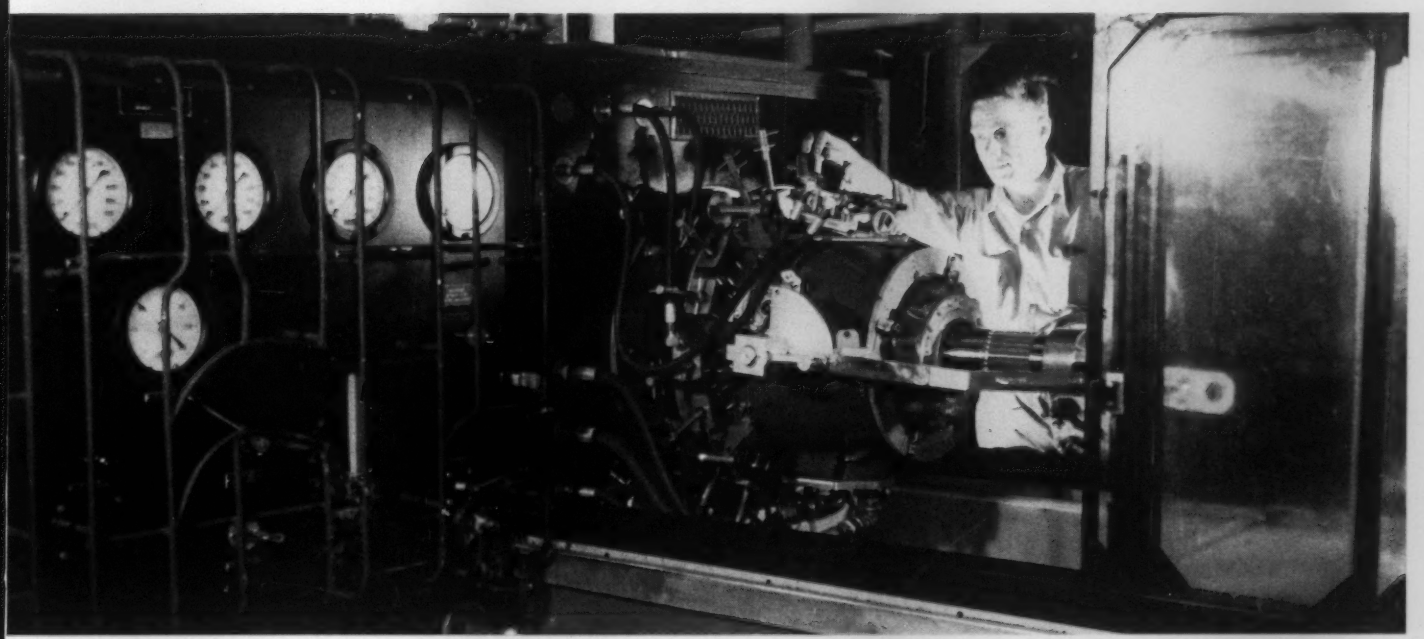


6 Bolts on the engine front section being tightened with an automatic machine. The splined shaft shown adjacent to the machine is the propeller shaft of the engine. The opening in the lower right portion of the engine is for the front oil pump and sump.

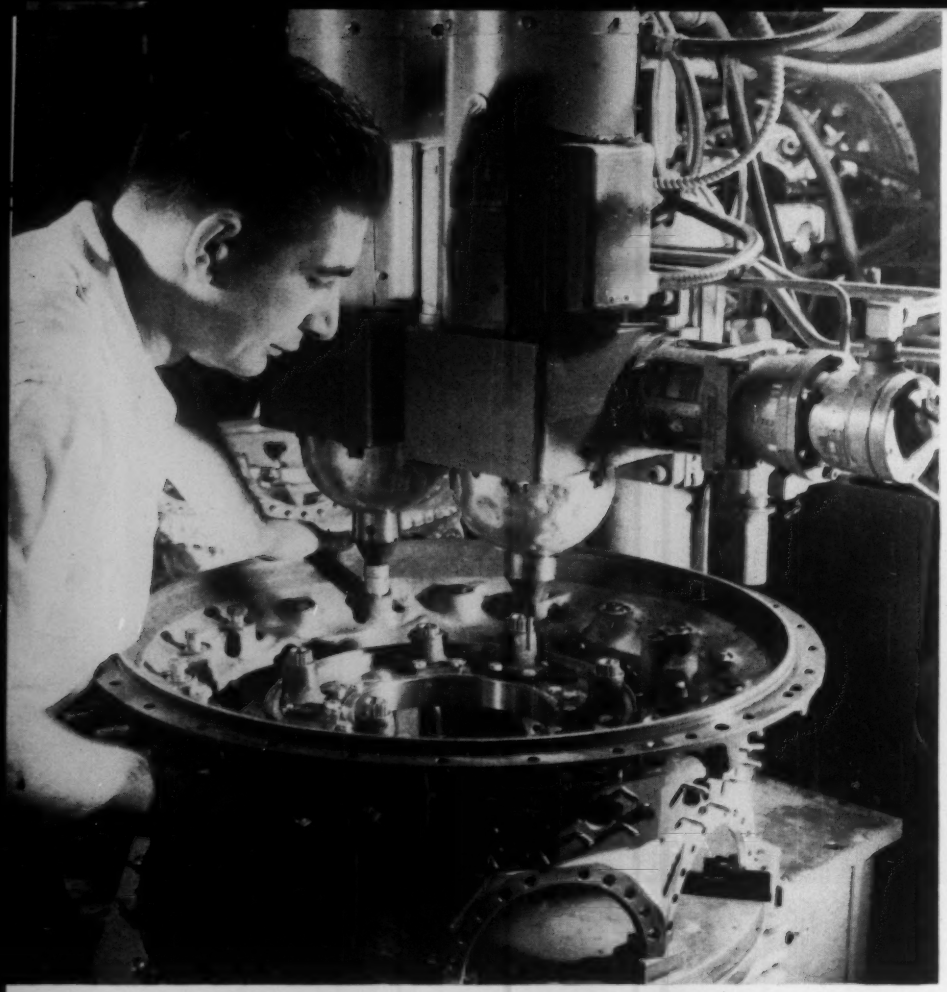


4 Pinion ring carrier machine tightens the bolts and crimps the fasteners for the reduction gear pinions positioned in the engine front section. This automatic machine is part of the green line subassembly section.

5 Bolt tightening on the front cam section by another automatic machine. The cam is assembled as part of the crankcase system, and the subassembly is put together and then sent to its next position for another phase of engine completion.



7 Oil flow rigs check the proper lubrication and free oil flow through the channels and engine bearings in the three major subassemblies—the front, power, and rear sections. The rigs flush any foreign material found in the external and internal areas of the engine during the 30 minute check. Both the green and final line have oil flow rigs for each of the major subassemblies. The front section is shown in the rig.



8 This automatic machine positions and tightens bolts of the engine tappet housing to the rear crankcase section. The tappet housing is positioned between the power and rear sections and houses the pushrod assemblies for operation of the cams and rocker arms through the cylinders. Each of the automatic machines for assembly is positioned in front of the assembler at working height and the assembly done with as little human error as possible.

11

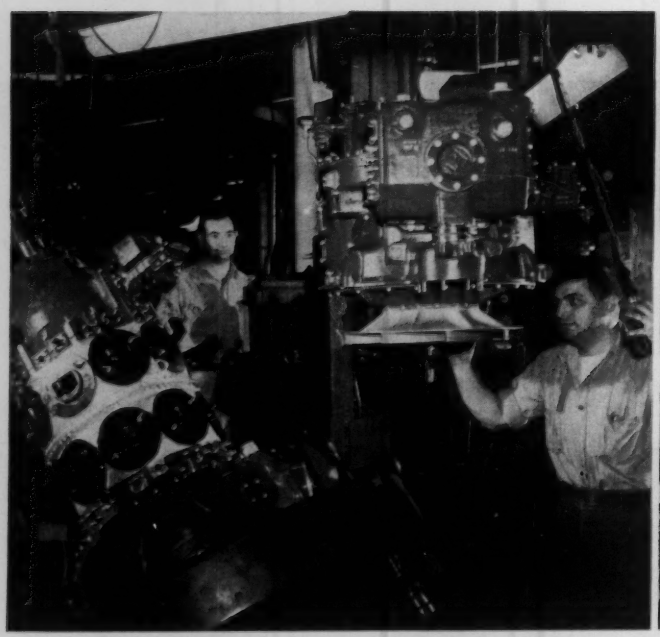


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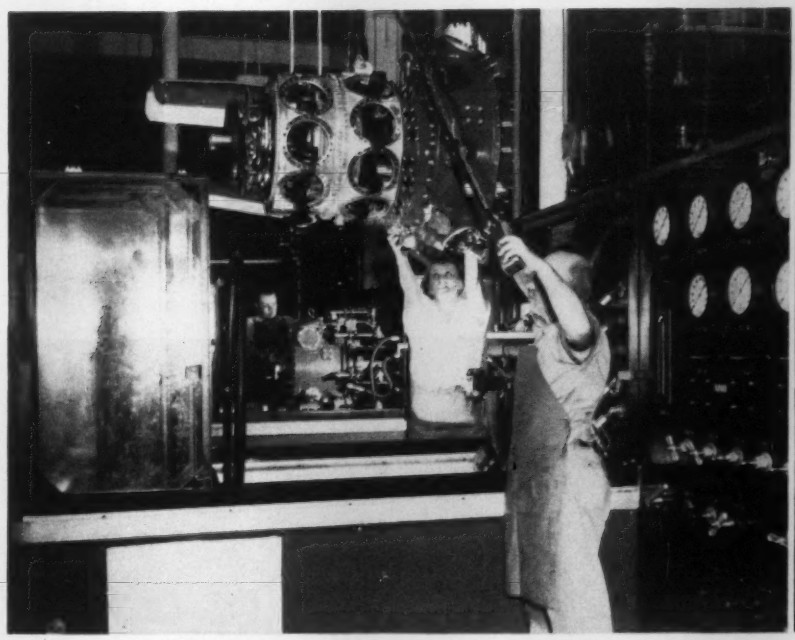
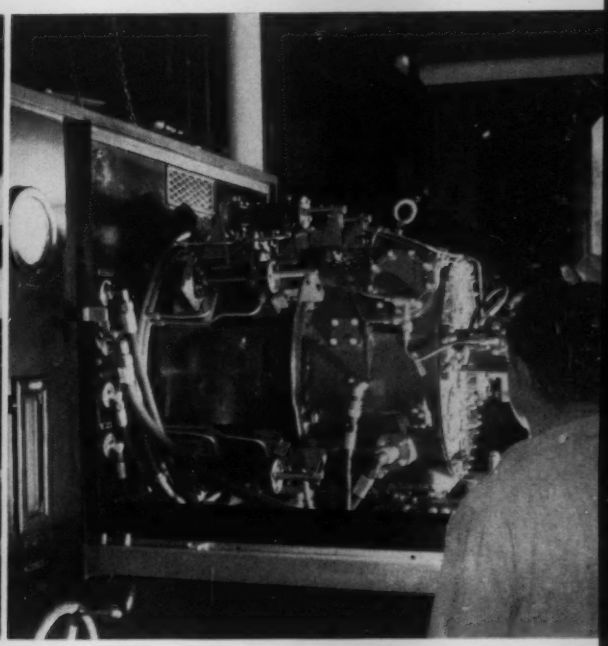
Fig. 11—The entire rear section of the engine being positioned for assembly with the two other major subassemblies—the power and front sections, both shown in the stand at the left. The machine brings the sections into correct alignment for assembly. When the front section is pointed downward, the rear part is placed into position by the men and the automatic machines. Assembled as integrated units, the completed subassemblies then go to the next post for cylinder installation. Fig. 12—Here powerized conveyor lines move pistons and cylinders to the Turbo Compound for installation. To the right, front-row pistons and cylinders are installed on the engine and to the left, the rear row. The assembled engine units are mounted on vertical rolling stands and clamped to special machines. These machines index the engine assemblies in order that the cylinder mount surfaces



9 Here the power section is being lowered by overhead monorail to the oil flow rig to position the engine subassembly for the tests.



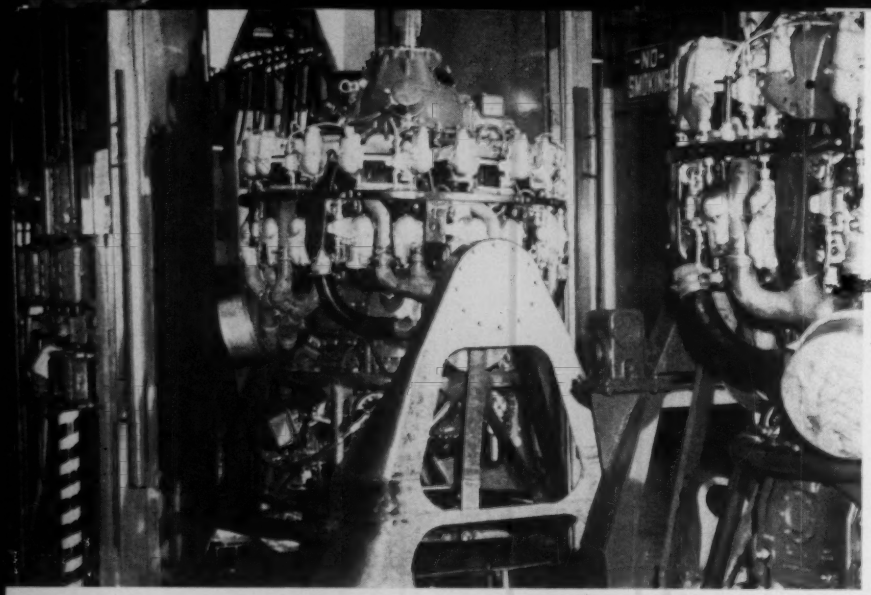
10 A Turbo Compound engine rear section is shown in the oil flow rig being prepared for test.

13

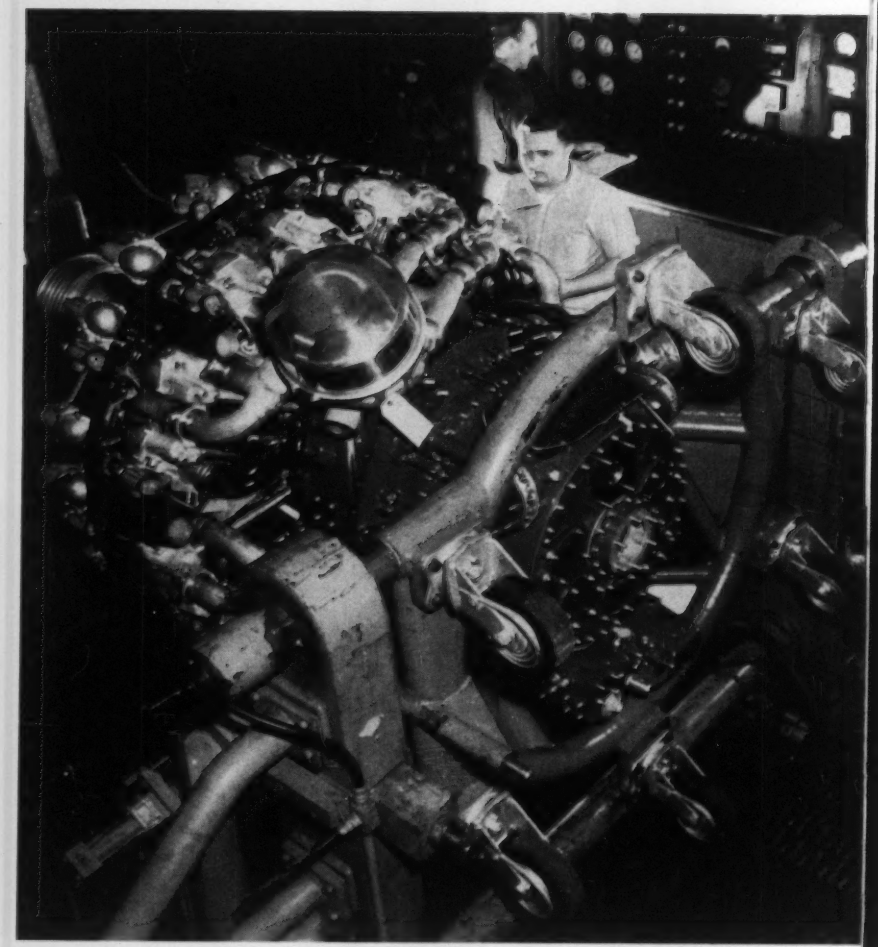
to be worked on face the assembler. At the same time the machines rotate the engine propeller shaft to extend the connecting rods for the installation of pistons and cylinders. Fig. 13—Here is shown a machine that tightens the turbine wheel nut and stretches the turbine shaft of a power recovery turbine. Three power recovery turbines are integral parts of the engine and no additional controls are needed for their operation.

14

Fig. 14—Shown are the green line (left) and final assembly line where the engines are positioned over a powerized floor type conveyor and progressed through 12 stations. At the end of each cycle the conveyor advances all engines one station. Here external parts, such as spark plugs, distributors, and power recovery units, are placed on the power plants. Both lines use the same methods, procedures, and sequences.

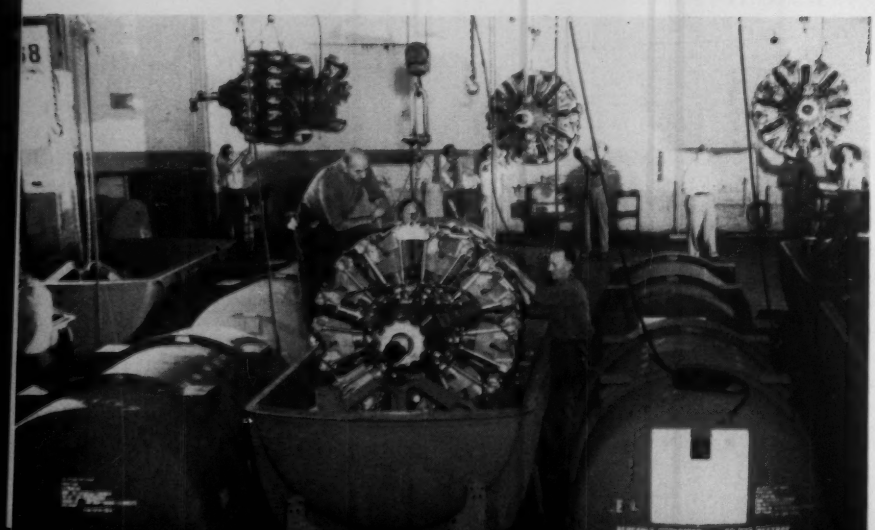


15 Two engines make ready to enter the wash house where they are given a two-minute wash with solvent, air-blown dry, and then delivered by tow trucks to the engine test preparation area. The engine stand is moved through the wash booth by the floor conveyor to which the stand is hooked.



16 Assembled Turbo Compound engine shown in the preoil rig where it is hooked up to stimulate actual running conditions. Here the various oil and pressure line connections are rigged to calibrate oil flows. The 3500-pound engine is hydraulically lifted into flight position for this test.

17 Packing engines for shipment is the last phase of the 13 stations in the manufacture of the Curtiss-Wright Turbo Compound on the automated progressive assembly line. Here packers position the engines in metal containers by use of overhead monorails. Engines in the background, being prepared for shipping, are moved forward to the metal containers. A specified amount of dehydrated air is injected into the container, which is then sealed and moved off the floor for shipment.



COMBINATION PACKAGE BUNDLER

Conveyor belt actuated mechanism automatically applies pressure-sensitive tapes to combine multiple packages

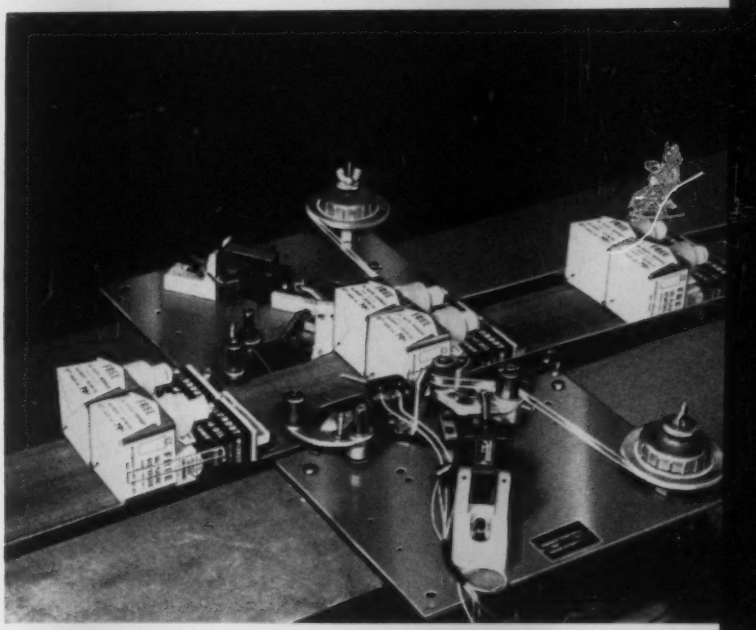


Fig. 1—Automatic package taping machine in operation combining special "deals"

TO PERMIT more efficient use of pressure-sensitive tapes for joining combination packages, a new production line packaging machine recently developed automatically tapes products into attractive, saleable "deals." This simplified bundler, designed by Minnesota Mining & Mfg. Co., utilizes existing conveyor belt systems and derives the necessary motive power from belt motion. Pusher cleats, built into the conveyor belt, carry the packages through the taping mechanism at a rate of up to 75 units per minute, *Fig.* 1.

Operational design of the bundling machine centers around one right-hand and one left-hand taping head over which the tape is automatically started, applied, and cut-off as the packages pass between the heads. Other components include antibacklash rollers, buffing rollers, and cut-off knives on both sides of the machine. The antibacklash roller is eccentrically mounted and lightly spring-loaded to pinch the tape against a similar concentric roller. This prevents backward movement, and yet permits withdrawal of the tape, *Fig.* 2.

After the tape has been applied by the application rollers and automatically severed by the cut-off knives, a second set of rollers buffs the tape to the packages for positive adhesion. Action of the cut-off mechanism is facilitated by rotation of the tape applying arm, with power being supplied directly to the mechanism by a solenoid. The solenoids—one on each side of the machine—are energized by switches actuated by passage of the packages through the mechanism.

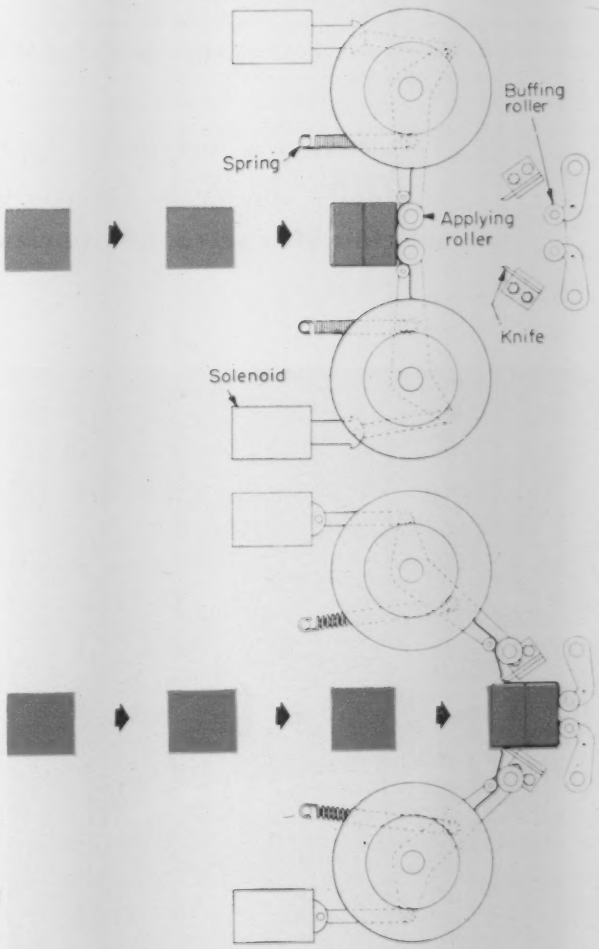


Fig. 2—Schematic drawing showing details of tape applying and cutting mechanism

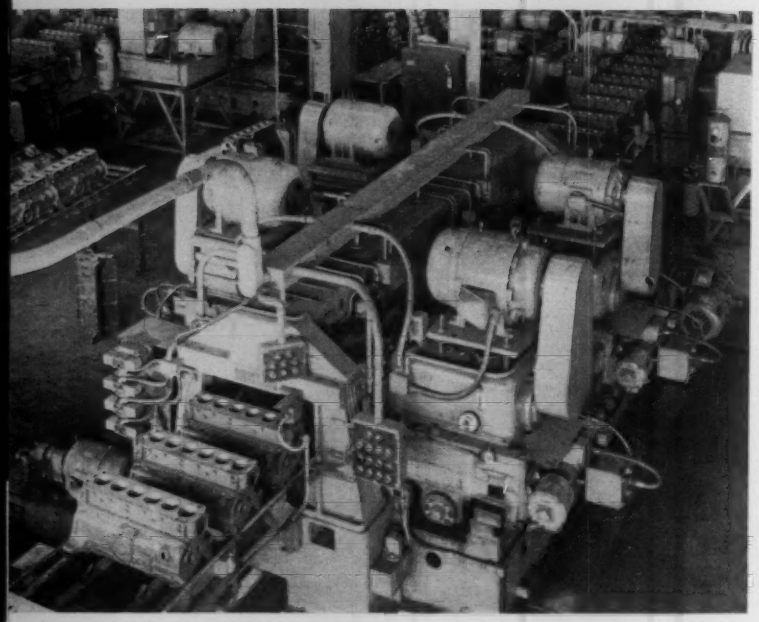


Fig. 1—Typical transfer machine for cylinder blocks. Cross-shuttled from previous operation, blocks are turned 90 degrees to enter the end milling machine broadside. They index continuously through the end milling machine and then through the end drilling machine

By DEL S. HARDER
Vice President, Manufacturing
Ford Motor Co., Detroit, Mich.

AUTOMATION

A MODERN INDUSTRIAL DEVELOPMENT

Automation as originally applied in automotive manufacturing has been gradually changing. Today's broader concept is clearly outlined in this article which sets a new horizon for this dynamic and growing field

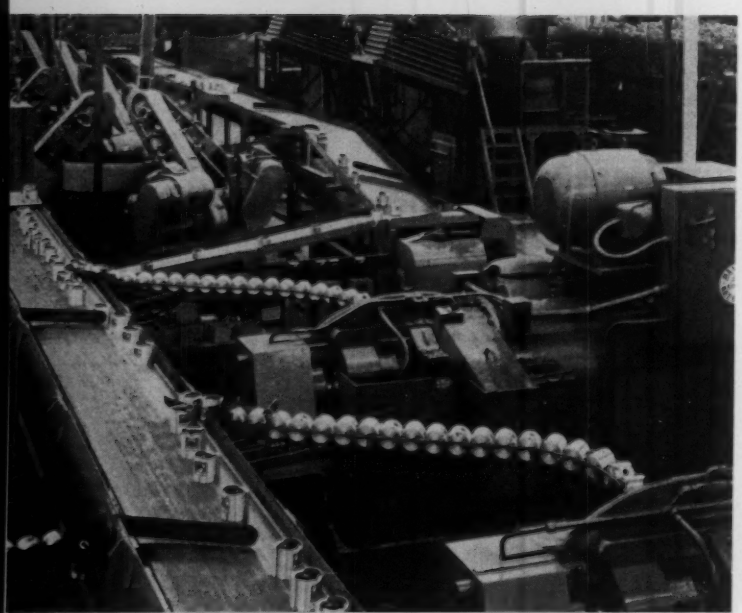


Fig. 2—Simple automation of existing machines for pistons. Group shown performs the operations of turning outside diameter, ring grooves and facing piston dome

RAPID INCREASE in the use of automation devices in our manufacturing industries has been one of the outstanding industrial developments of the last decade. In these few short years, automation has changed the concept of manufacturing processes to the extent that we must today take an entirely different approach to the design and selection of all of our machinery and equipment than we did at the beginning of this period.

To develop this theme, we would like to compare our definition of automation as we thought of it in earlier programs to our present-day concept. The earlier definition that "automation is the automatic handling of parts between progressive production processes" was adequate to define the subject so that our engineers and those employed by the machine tool builders could understand our requirements for new plants.

While this basic definition is still substantially correct, we find that it is now necessary to expand our look at production methods from the standpoint that we must consider the effects of automatic handling on each and every phase of our manufacturing processes. It is this broader concept of the

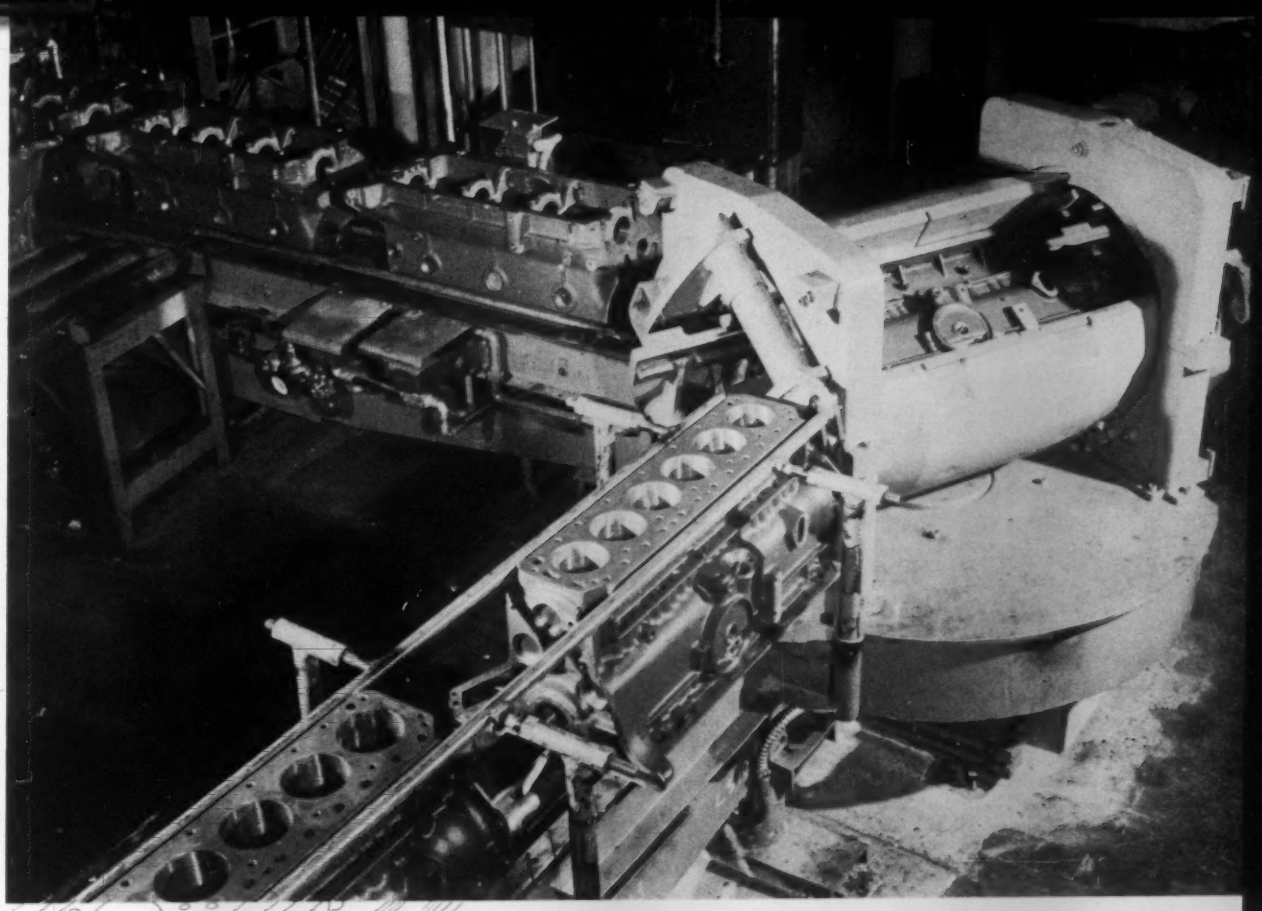


Fig. 3—Modern cylinder block automation. Blocks which have just left the last operation in the department are shown, lower center, positioned on the automation equipment typical throughout. Turntable receives a block in normal sequence of operation, turns it 90 degrees in a horizontal plane and 180 degrees vertically to deliver it to the automation mechanism which carries it to next production operation

use of automation that will be developed in this article. To do this properly, there are several main subjects which should be discussed to give adequate coverage to the subject. These are as follows: (1) Transfer machine tools, (2) automation, (3) control for the automation system, (4) preventive maintenance, and (5) effects on labor and management.

▶ Transfer Type Machine Tools

In selecting machinery for production lines of a few years ago, the processing was based on the use of individual machine tools. Each of these machine tools performed a small increment of the total work required to complete a given part. It was the job of the machinery user to tie these individual machine tools together with conveying devices, such as roller conveyors, which were available on the open market. These devices normally required a considerable amount of manual handling in connection with their operation.

Today, our processing for machining operations must be based on combining of similar operations into a machine tool of many stations with automatic transfers between the individual stations. This combination of operations in one machine is quite commonly called a transfer machine.

In the development of the transfer machine, it is apparent that the principles of automation were the motivating force. We can best illustrate the results of automation thinking in the transfer machine by an example in the production of automotive crankshafts. In manufacturing a crankshaft, we are called upon, in the course of the operations, to drill six oil holes, six metering holes, and six lightening holes. In the early part of the past decade, it would have required 29 separate machines. Today, using principles of automation in the transfer machine, it would require only 3 separate machines of 8 stations each. It is only necessary to load one end of the machine and unload from the other end, with all operations in between being completely automatic.

This new approach to processing has resulted in a 40 per cent reduction in floor space requirements and has reduced the amount of direct labor

required. At the same time, there has been some increase in the indirect labor requirements in order to properly maintain the automatic features of this machine.

This revolutionary change in processing methods has caused profound changes in our entire production processes. We have found it necessary to redistribute manpower and to take a new look at our methods of maintaining machinery and in applying our tools to the job.

In many of our factories today, production lines are made up of groups of transfer machines which are completely automatic in themselves and which, in turn, are coupled together to gain full benefits of the transfer machine. A typical example of this application, *Fig.* 1, shows two machines are connected by automation. In the drilling machine, 10 holes are drilled in the front face and 20 holes are drilled in the rear face. Approximately 100 tools are used in all as the block is indexed through the 35 stations of these machines. Automatic checking stations are used which stop the machine cycle when a drill has broken or failed to produce a hole to the proper depth.

Automation

In discussing the transfer machine, it is usually pictured as being developed largely within the past decade. However, there are examples existing in industry which go back considerably beyond this period. Some of these were developed within the plants of machinery users. These early examples planted the seed which gradually developed into our modern-day concept of automation.

Inasmuch as individual transfer machines for our major parts are built by several different companies, there still remains the substantial problem of connecting transfer machines together so that manual handling operations between the various machines will not be necessary. We can see that the basic principles of the transfer machine have been utilized in a few cases for a considerable period of time, and, as we all know, the conveyor was a symbol of mass production in the very early days of volume production of automobiles. Conveyors were used for transferring parts from department to department, for storage of materials, and for assembly operations.

It is natural that our first steps in automation between machines should be taken with existing machines. This was done, as an example, in the manufacturing of automotive pistons, where standard type machine tools were grouped in such a manner that a series of belt conveyors could distribute the parts from one group of machines to the next group. A series of deflectors on the belt conveying system removed pistons and directed them through individual machine tools.

The automatic features of the machine tool took over to perform the operations and then, automatically ejected the part to be returned to the conveyor system on a belt directly under the delivery belt. By this simple means, we were able to use automation in the existing machines, *Fig.* 2.

These principles of automation utilizing conveyors, plus the gradual development of the transfer type machine, have today reached their maturity in that our new programs are based on the use of machinery and equipment which have been designed with automation in mind. In other words, when the machinery is selected, it is based on the use of the transfer machine. Its location in our production facilities is based on the utilization of automation between the transfer machines wherever it is practical and economical to do so. An example of automation installed in one of the latest plants for manufacturing engines is shown in *Fig.* 3.

Automation devices are designed to handle a large variety of parts and perform the operations of moving these parts into and out of machines, turning the part over, rotating it, removing scrap, and other related functions. Scrap removal on a continuous and automatic basis is a necessity in both machining and stamping operations. These devices are timed with the process and quite often are completely automatic while in operation.

In the design of automation equipment, many standard devices are employed—conveyors, air, hydraulic, and electrical control mechanisms, etc.—and arranged to obtain the desired movement for elimination of inherent delay in the form of unnecessary manual handling operations. Examples so far have been based on machining operations. However, these same principles are utilized on other types of operations as well. *Figs.* 4 and 5, for instance, show operations in handling roof panels as they are removed from the draw die. Thus, in stamping operations automation devices can remove the part, position it, and turn it over in proper position for the next operation.

Principles of automation have also extended into assembly operations. In *Fig.* 6 are shown engines suspended on a carrier over the engine test stands in one of our plants. This carrier has been fastened to the cylinder block at the first operation in the assembly process and is not removed until the engine is completed and ready to be fastened into the shipping rack. As the engine passes through the various operations, it is possible to automatically switch into areas off the main assembly line, such as repairing or testing, without the need for manual handling by bridge crane, which was the method formerly used.

This principle in assembly operations has been worked out in conjunction with the conveying system, commonly known as a power-and-free system. It is apparent that in the operation illustrated, considerable amount of handling has been eliminated by retaining the engine on its carrier while it is being tested. Upon completion of the test, the engine is transferred back into the main con-

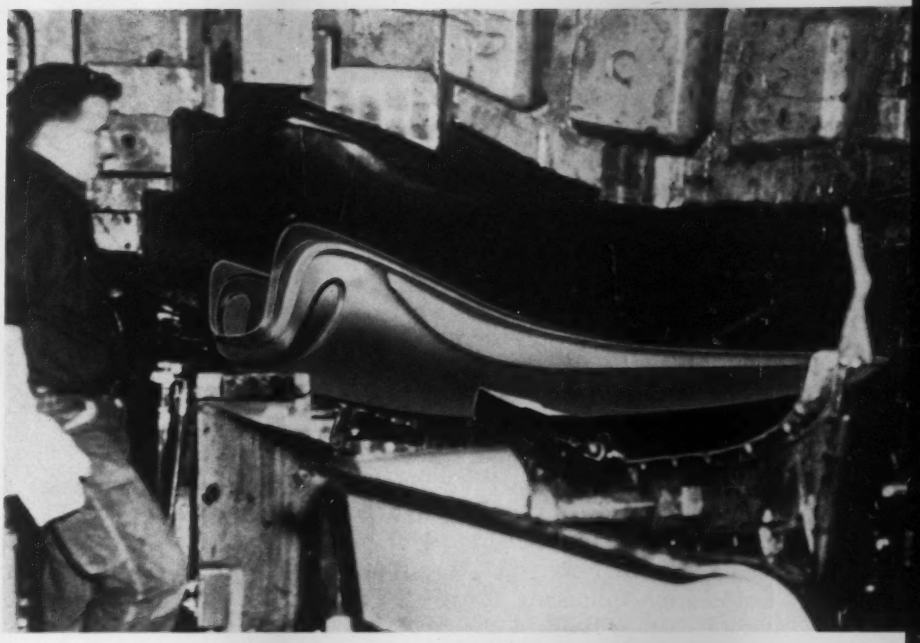


Fig. 4—Automation mechanism at right is extracting roof panel from draw die. Extractor is air actuated and controlled by press movement. Unit reciprocates on a guiding device parallel to panel travel

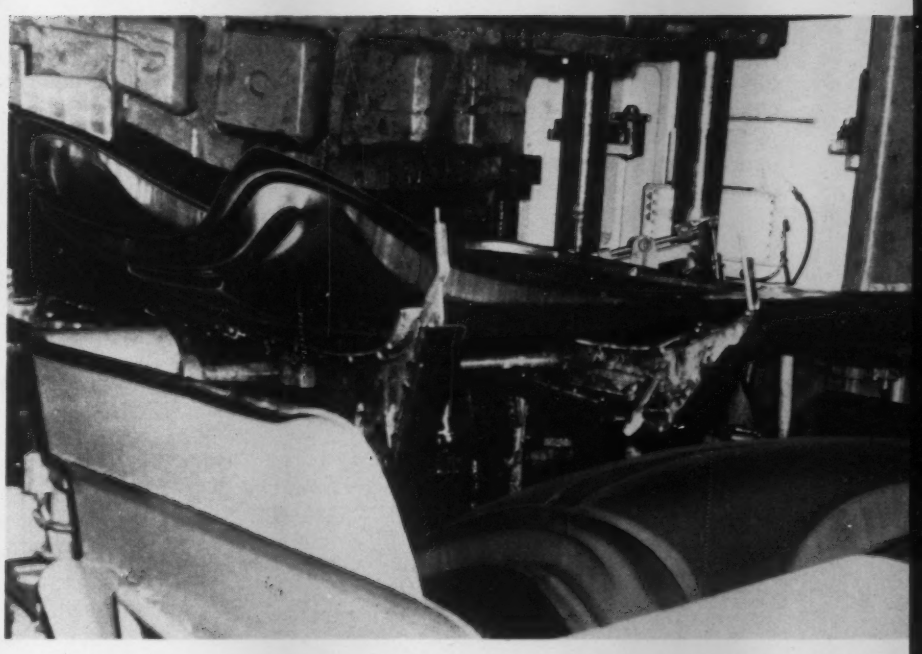


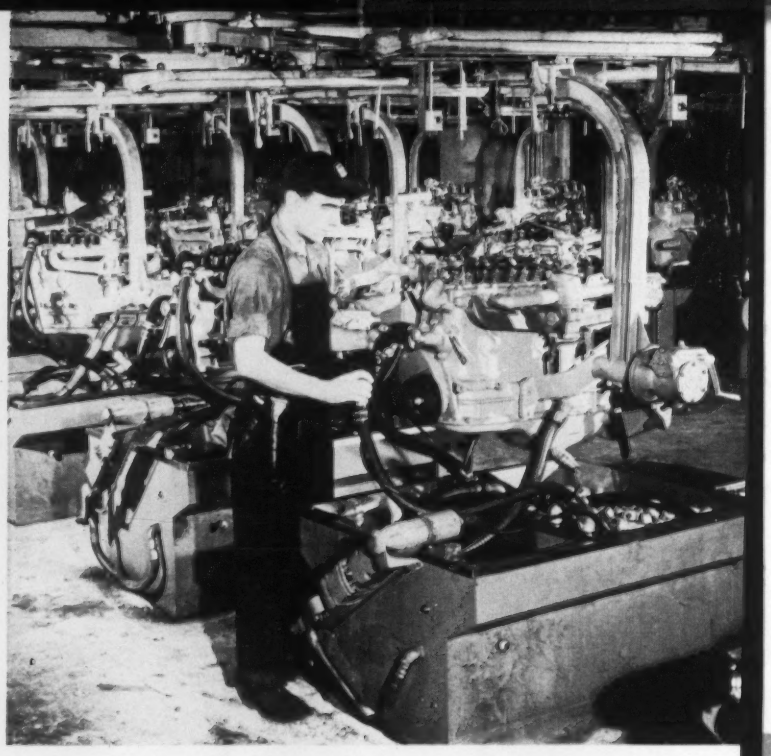
Fig. 5—Roof panel removed completely from die resting in a turnover cradle. Automation device in center rear is ready to remove next piece in the cycle of operations. Completely inverted panel is also visible

veying system by the simple operation of actuating an air cylinder which will open the switch.

From these few examples, it can be seen that a wide variety of materials can be handled with substantial savings. In many respects, automation is the extended usage of conveyors which played such an important part in the early mass production of automobiles. The main difference today is that we have recognized the principles involved, have defined them as automation, and must think in terms of automation in planning all of our facilities.

In the early days of automation design, we found, quite often, that the work was done by the cut-and-try method—often the case in a new development. Today, however, automation has become an important part of our equipment designing activities and we look upon it as we would any other phase of our manufacturing processes, such as, the need for machining, press forming, washing, heat treating, or assembly. We feel that automation must be considered at the same time that all of the other portions of the manufacturing process are developed. If it is not considered early in our planning programs, we have found that it is often impossible to make an adequate installation at a later date.

One of the things which has greatly assisted us in developing automation programs is the drastic change in product which has occurred in recent years. New products have meant completely new



manufacturing facilities in many cases. Completely new manufacturing facilities make it possible for manufacturing engineering people to apply the latest devices known for the manufacture of these new products.

In the Ford Motor Co., we took advantage of this opportunity wherever possible and insisted that our knowledge of automation principles should be applied to the manufacture of the new products. Economic considerations make it necessary that new facilities be as modern as possible and not include unnecessary material handling.

The idea of using automation between transfer machines has been a subject of much discussion. Many people have said that there is too much automatic equipment involved and that maintenance costs will offset the advantages of the automation. We feel that since deciding to use transfer machines, we have already committed ourselves to automation which ties together many operations. The tying together of transfer machines is the logical step to make the process complete. It certainly is only a small portion of the overall improvement in handling which we have accepted in the transfer machine. If the same principles of maintenance are applied to this added automation, operations should be satisfactory.

We have discussed automation in a general way to indicate the scope of a modern automation program. It is apparent that there are many benefits which can be obtained. The following is a summary of the main points:

1. *Lower Production Costs:* Automation assists greatly in lower production costs by relieving manual effort required in handling parts and by reduction of inherent delay, especially in our large-volume operations. The manpower savings made have been accompanied by redistribution of manpower, which is resulting in the need for more skilled workmen. It has eliminated much of the monotonous, repetitive work while, at the same time, it has increased production.

2. *Increased Machine Speed:* In certain of our machines, such as in press lines, the speed of operation is determined by the load and unloading operations. Automatic transferring operations have made it possible to operate machines nearer to their maximum capacity with the result of greater use factors for our machines. In the operation of our presses, this often results in less stopping and starting and, consequently, less wear on clutches and brakes. This greater utilization of expensive production machines is an improvement which obviously has definite advantages.

3. *Quality:* Automation has helped improve quality by reducing damage caused by parts hitting each other or falling to the floor. In some cases, we have found it necessary to build our quality control gages into the production line and tie it into our automation equipment. A good example of this is in testing of cylinder blocks for leaks, *Fig.* 7.

4. *Safety:* Automation very often can be utilized to handle cumbersome parts which are hazardous even with the best safety devices. This utilization of automation, such as in handling stampings into and out of presses and at turnover operations, assists in improving overall safety conditions.

Planning for Automation

In developing automation, we have found it necessary to set up departments concentrating on this phase of our business. We have had to train people to compromise on the utilization of conveyors, which had comparatively loose tolerances, and normal tool and die design, which had much closer tolerances. The automation designer must combine these two elements with his imagination, engineering knowledge, and general design experience in order to obtain a satisfactory system.

As mentioned previously, it is our feeling that an automation program begins early in the program of planning for new facilities. As the preliminary plant layouts are being developed, the automation designer must be available so that arrangements can be made for the installation of the simplest possible transfer mechanisms.

At this stage in the program, quick calculations and simple sketches must be made to determine in a preliminary way the extent of automation which is justified by the economics and other related factors. The part to be produced must be carefully studied for adaptability to automation. Preliminary manpower estimates for the operations being studied must be considered. Once a plant layout has been prepared, the automation engineer can start his detailed study of the program.

An overall preliminary automation layout is made and, in some cases, models and perspective drawings are prepared. When the extent of the proposed automation equipment and its estimated cost has been determined, it is then necessary to have manpower estimates made by our industrial engineers both with and without automation. Compilation of this data and the cost of the automation in summary form are prepared for approval.

When the program has been approved, the real job of co-ordinating begins. Plant layouts are finalized, the processing department is notified so that the operation sheets can include the effects of the automation equipment, the tool and die design department is consulted so that proper clearances can be left in dies and tools for introduction of automation devices, and the machinery and equipment builders must be consulted so that work heights are standardized and they are familiar with the intent of the program.

When all of these steps have been taken and a final automation layout has been prepared and approved, we then have the problem of writing specifications for procuring the equipment. In our experience, the most desirable way of procuring the equipment is to secure a contractor who will design, fabricate, deliver, install, and test the equipment. Because of the nature of the equipment, we feel that it is necessary to fix this responsibility in the hands of one party if it is at all possible. We find it possible today to accomplish this much more readily than just a few years back.

One thing which we feel is extremely important in developing an automation program is the development of the economic factors involved. Automation expenditures must pay for themselves in the same manner as other improvements in manufacturing processes. In the automobile industry, we find that because of yearly models, certain parts change from year to year and, consequently, automation equipment must pay for itself within this same period. However, there are many cases, such as in our press lines and body parts machining lines for engine and chassis parts, where the parts retain their same basic shape for an extensive period. Consequently, the basic automation equipment can be amortized over a longer period.

Controls for the Automation System

The greater utilization of transfer type machines and automation has resulted in the need for better control systems. These control systems make it possible for all elements of the machinery and equipment to operate in harmony with each other.

There are two types of control systems which we feel are extremely important in conjunction with our automatic processes. The first is the electrical control center, and the second is the tool control board. When an industrial user purchases transfer machines and interlocking automation devices, the key to its successful operation is an adequately engineered electrical system which controls the movement of parts between individual stations of the transfer machine and between transfer machines without delay. The electrical system must be so arranged that a part is loaded into a machine as quickly as possible after the operational cycle of the machine shuttles the preceding part

Fig. 6—left—Automation in assembly operations are typified by devices such as this engine carrier arrangement

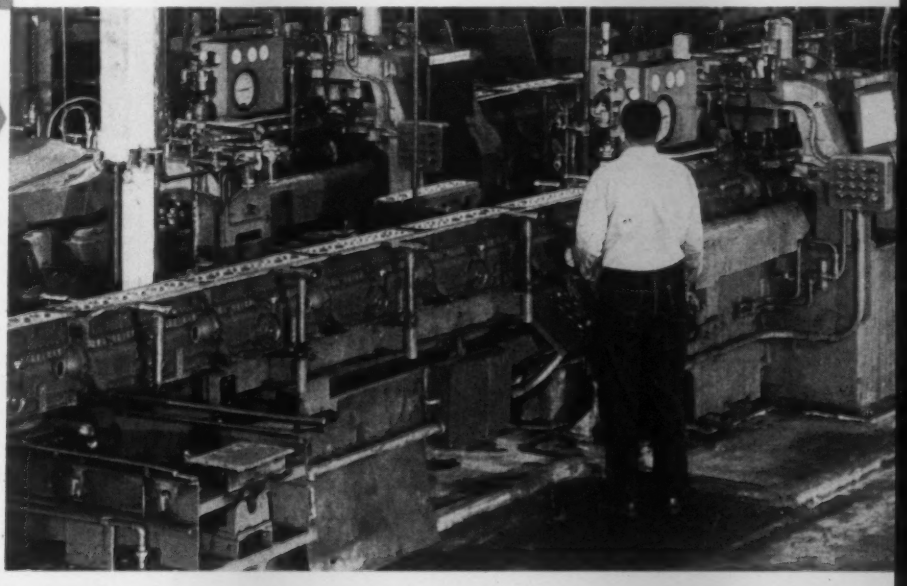


Fig. 7—right—Automatic testing of cylinder blocks for leaks. Subjected to air pressure, blocks with leaks result in pressure drop actuating a system of electric solenoids and control valves to reject faulty units

to another station. By the same token, the control mechanism must prevent a part from moving into a work station until that work station is ready to receive it and all tools are cleared from the part.

Modern practice for electrical controls necessitates the building of an electrical nerve center which contains the essential electrical control devices for a given machine and its related automation devices. The accompanying *Fig.* 8 shows a large control center with many relays and with the wiring exposed for easy maintenance.

The tool control board is a very recent development which is brought about by the need for close tool control on the transfer machine in order that machine down time be kept to a minimum, *Fig.* 9. With the transfer machine, when one tool fails, the entire machine is shut down. With the increased number of tools to change, adequate control is a necessity. The tool control board has assisted greatly in improving tool trouble conditions. The basic idea behind this development is that each transfer machine shall have a tool control board with a definite place for storing tools which are ready to be placed in operation as required. These tools are preset in their holders so that they can be placed in operation in a very short period of time without the need for making extensive adjustments to the machine tool.

Another feature of the tool control board is the toolometer dial, *Fig.* 10. These dials are basically a simple timing device. Each group of similar tools has a dial to control its replacement. The toolometer dial is set to indicate the number of pieces which a given tool should produce. When the dial has reached that predetermined figure, the machine is shut down and the tools are changed. At the same time, other tools which are approaching the end of their economical life are also changed to prevent frequent machine shut downs.

This tool control board has served to keep production machines going and, also, has assisted greatly in controlling tool life. Tools which are removed before they are completely worn out can be reground and used over again.

THE AUTHOR

D. S. Harder, vice president - manufacturing, is the staff executive directing all Ford Motor Co. manufacturing and production. He joined Ford in 1946 as vice president-operations, and within the next year became vice president -manufacturing with the expanded scope of activities he now directs. He has been the key executive in the expansion and modernization program which has given the company more than 26 million square feet of additional space in 13 new manufacturing plants and seven new assembly plants.

Originator of the term "automation" which has become accepted throughout industry, he personally began using the word as early as 1935 when he was associated with the General Motors Corp. as general factory manager of the Fisher Body Div. At Ford, the first automation dept. was set up in early 1947 to cope with automatic handling problems. Mr. Harder's introduction of automation in pressed steel and engine work is considered the major innovation of the past decade in automotive manufacturing.

Preventive Maintenance

The program of preventive maintenance is one which all manufacturers should utilize. It is mentioned here because it is particularly important since we are specifying large quantities of automatic machinery and automation devices which must be properly maintained if they are to accomplish their intended purpose.

Modern production lines are geared to produce a definite number of units per hour. If we lose these units, they cannot be made up; consequently, we must consider our maintenance program from the standpoint that we must keep adequate machinery and equipment report records, we must lubricate on schedule, and we must be constantly checking our facilities to be certain that they are being maintained properly.

The purpose of a preventive maintenance program is to statistically determine the anticipated life of perishable parts of our mechanical equipment and to see that these parts are replaced before a complete breakdown occurs. Lack of a preventive maintenance program can soon cause an adequately engineered production line to disintegrate into a low-producing, high-cost system.

Production processes have become complicated to the extent that we predict that lack of a preventive maintenance program will result in the failure of a plant to meet its production schedules and to keep its costs in line. In recent years, there have been many developments which have occurred to greatly assist maintenance engineers in developing a preventive maintenance program and in maintaining production. As an example, we refer to the Joint Industry Conference Standards which are a collection of sound engineering and installation practices. They provide detailed specifications for the application of electrical, hydraulic, lubrication, and

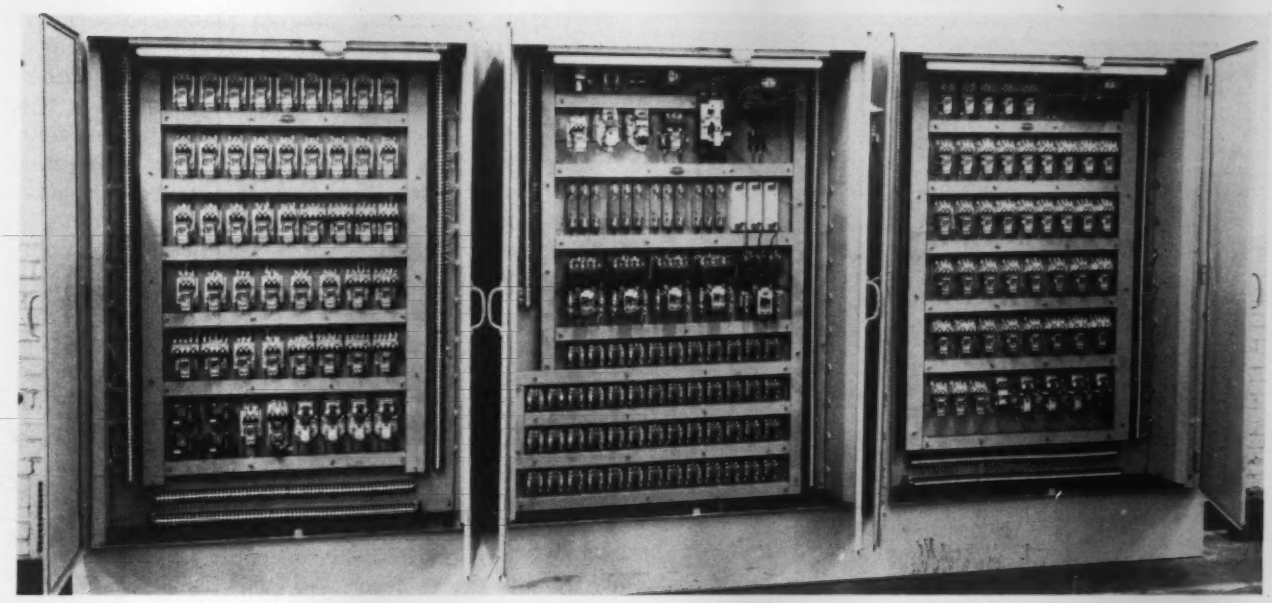


Fig. 8—Large electrical control center with relays and wiring exposed for easy maintenance

pneumatic apparatus to production facilities.

Many manufacturers have seen it fit to expand on these Joint Industry Conference Standards and set up a standards program of their own. These standards are based on logical systems of identification, greater accessibility of components, and better protection from contamination and hazards. As a result of the joint efforts of all concerned, improved electrical control enclosures have been developed, identification has improved, provisions for mounting, removal, and safety have all been greatly improved.

Today, an electrician can detect the cause of trouble, put the equipment back in operation in a minimum amount of time because he has ready access to electrical devices, and can easily identify electrical circuits with more adequate identification.

In the application of oil reservoirs and power units, there has been a great improvement. It was often common practice to locate hydraulic reservoirs in inaccessible locations under machines. Hydraulic tubing and wires were intermingled and produced unsafe conditions. Today, these hydraulic components have been removed from under the machines. The various elements of the control mechanisms are readily accessible. Reservoirs are sealed to prevent contamination and the general construction of the entire hydraulic system has been greatly improved.

Another example is in the press room where there was formerly a wide variation of size and spacing of tapped holes, T-slots in bolster plates, and rams of presses for mounting dies. Conference groups established standard spacings for mounting holes which resulted in a greater interchangeability of dies between presses of different makes in the case of breakdowns or transfer of equipment from on plant to another.

In automation equipment, much has been done to develop standard sections which can be utilized in various locations and interchanged, if necessary. There has been considerable amount of very recent work in developing standard drive units for automation devices which can be replaced readily with a minimum of time lost.

From the foregoing, it can be seen that preventive maintenance is a "must" in our factories and that the standardization which has taken place is a necessary element of an adequate maintenance program. Extended use of the principles of automation have made this approach mandatory in a well-managed plant.

▶ Effects on Labor and Management

In departments which use automation, production processes have become much more complicated as a result of efforts to remove that portion of the

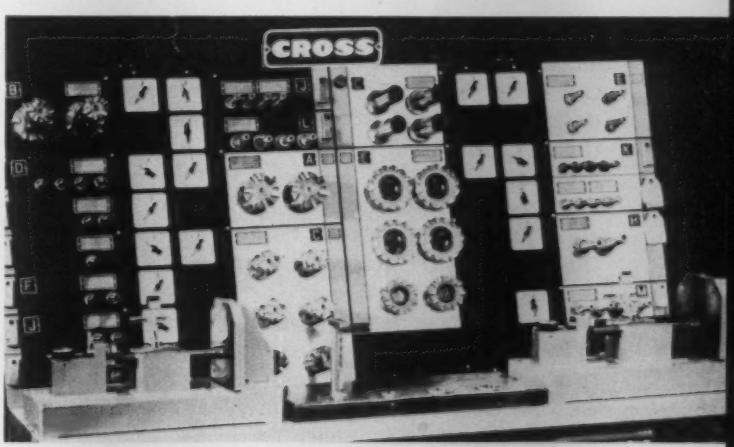


Fig. 9—Typical tool control board and toolometer dials for timing tool life

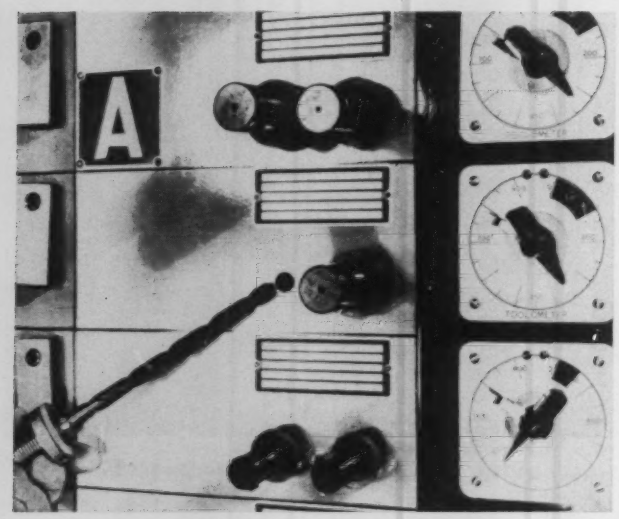


Fig. 10—Enlarged view of the toolometer dial

labor which was largely devoted to manual handling of parts. By doing this, our production processes have very often become a series of departments producing different parts, each of which is, in effect, one large transfer machine. In our maintenance program, latest methods must be used to keep machines operating and tools in first-class condition. The labor required in these departments discussed must be selected on the basis of ability to recognize troubles that are threatening. It is apparent, therefore, that our production people must be more highly trained on the average than in the past. Our management has found it necessary to assist in preparing workers for this new type of work. The worker benefits by obtaining jobs less monotonous and boring and, consequently, much more interesting.

Behind our production lines, we have found the need for more people in the manufacturing engineering field. In developing automation systems, higher skill is necessary than designing the simple devices formerly used. Specialization is much more necessary today than in the past and, at the same time, various engineering groups must understand each other's problems in order that the end product of our efforts will be an integrated process.

A greater utilization of automation has already clearly indicated that we require more brain power throughout our factories if we are to continue to replace a large portion of the muscle power which we have been accustomed to in the past. The management of a plant with extensive automation has, to some extent, become more complicated. While we still have the same old problem of dealing with human nature, it has been found necessary to have a considerable number of individual engineering groups, each specializing on a certain phase of our production processes. Modern plant management is faced with the problem of co-ordinating these individual engineering groups with all the other departments necessary to control production. Top management of plants must be able to promote teamwork in the entire organization in order that all phases of production planning are co-ordinated. Plant managers must keep themselves flexible to make the best of the various technical skills available for planning purposes.

Future of Automatic Processes

It is not our intention to act as prophets in predicting the future of automation, but rather to evaluate the progress which has been made in the last few years and, in some way, indicate what might be expected in the future.

In the Ford Motor Co., we are continuing to make the most of our engineering knowledge to extend the use of transfer machines and automation. The basic principles of automation have been known for a long time, however, it has been only in the last decade that a large cross-section of our manufacturing industry has concentrated on the development of the principles of automation.

We have found in discussions with people in the automotive industry as well as those in other manufacturing industries that automation is being given wide consideration. Many changes that are taking place in our product are giving the engineer an opportunity to apply the latest thinking. The general trend of product design is to provide the public with a much wider selection of products containing many advance features which were not contained in their earlier designs. It is the responsibility of manufacturers to find ways and means of producing these added features at an economical cost so that a wide distribution may be obtained. We feel that automation is an important concept which must be used in fulfilling this responsibility.

Use of automation has progressed to the extent that it is now thoroughly recognized that in building a new modern plant it should contain automation. A few years ago, automation in a plant was a novelty. We are fast approaching the point where a new plant which does not have automation will be looked upon as one which is backward in its manufacturing processes. We are referring here, of course, to plants which are adaptable to automation based on product design, volume requirements, facilities requirements, and all of the related economic factors.

Our concept of automation has expanded from a simple definition involving automatic handling between operations to a concept which has engulfed planning for all of our manufacturing processes. This change has taken place in a few short years and it is apparent that similar changes will continue to occur as new products and changes in old ones necessitate expansion or rearrangement of existing facilities.

NEW GYRO CONTROL

. . . HAS NO BEARINGS

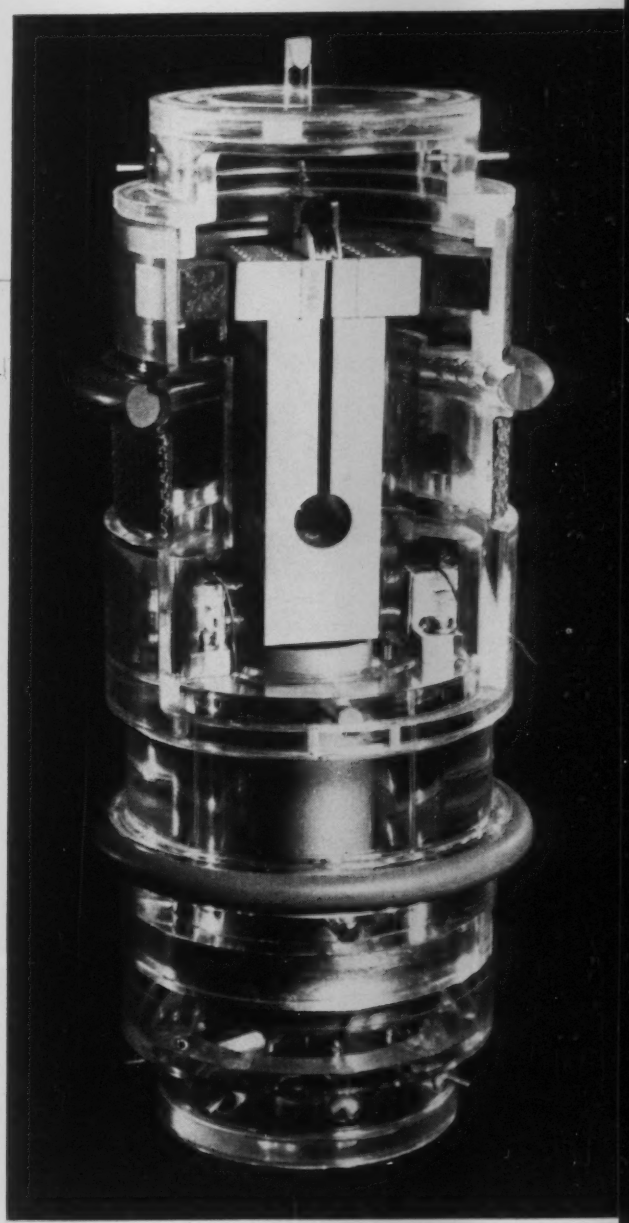


Fig. 1—Model of new Sperry Gyrotron vibrating rate gyro which utilizes a tuning fork to sense rate and direction of turn

Developed for aircraft-flight instrumentation, this vibrating rate gyro offers unusual possibilities for automatic control applications

DEVELOPMENT of precision control systems to meet the high-performance requirements imposed by modern aircraft has placed many new, and often severe, demands on methods of instrumentation. Concerted research effort has been directed toward the perfection of better equipment offering both ruggedness and high accuracy under flight conditions. A particularly significant result of this effort has been the recent development, by the Sperry Gyroscope Co., of a new and different type of gyroscope which, although still under refinement, offers a wide variety of attractive possibilities in the field of angular rate measurement and control, *Fig.* 1.

The Gyrotron vibrating rate gyro is based on a principle, first discovered by Foucault in 1850, analogous to that employed by insects to maintain balance in flight. Operating element of the new device is a continuously vibrating tuning fork, *Fig.* 2, in contrast to the gimbal-mounted spinning wheel construction used in conventional instruments. Rotation of the fork body produces torsional oscillations in the heel of the fork which provide indication not only of the rate of change but also of the direction of change of orientation of

Article based on material supplied by the Sperry Gyroscope Co.

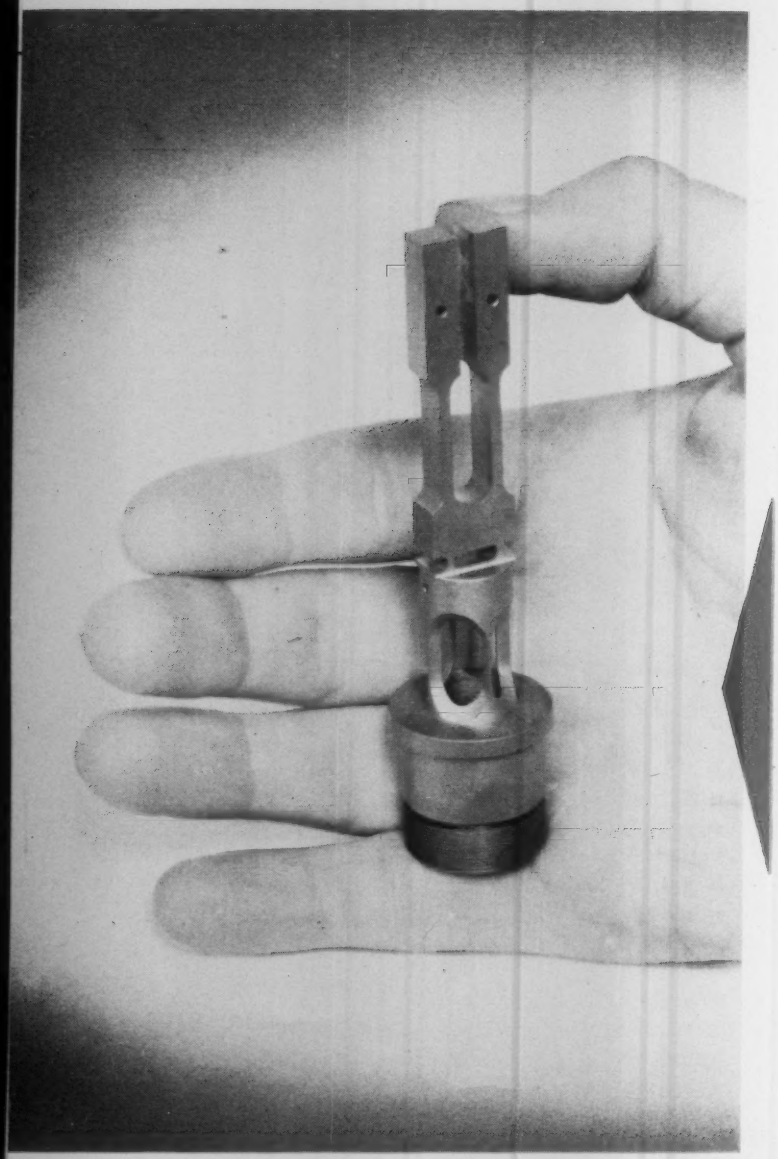


Fig. 2—Closeup view of typical sensing element of vibratory rate gyro

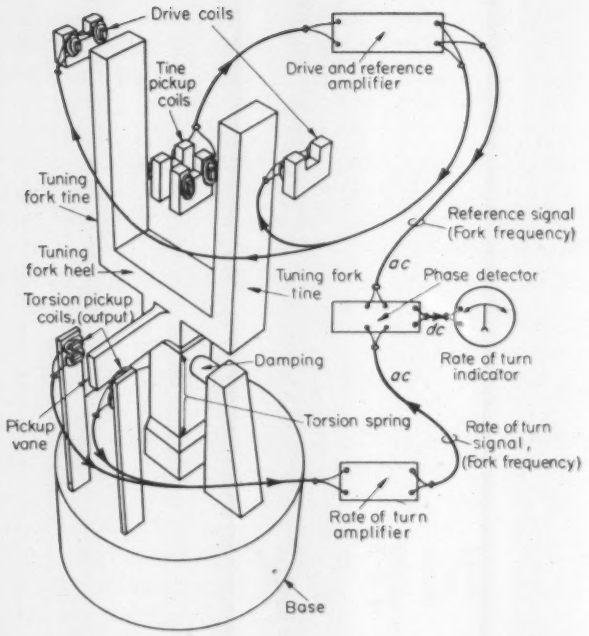


Fig. 3—Schematic diagram showing arrangement of basic elements in the Gyrotron vibrating rate gyro

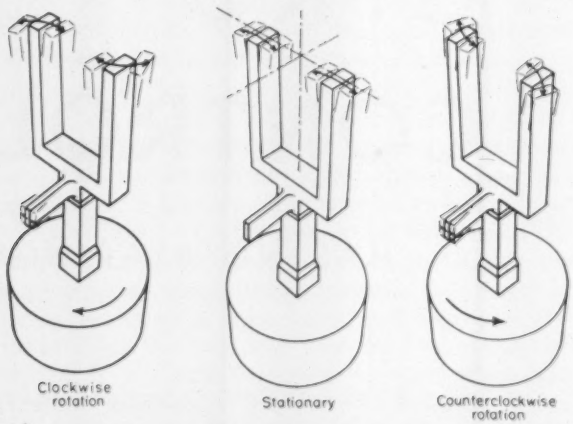


Fig. 4—Symbolic diagrams showing effect of direction of turn on the vibratory motions of the fork tines and pickup vane in the unit in *Fig.* 3

the surroundings—an inertial, spatial reference signal is produced. The significant inherent features of the new design, which will vary in importance according to application requirements, are:

1. Unique sensitivity. The vibratory gyroscope is sensitive only to angular velocity about a single input axis.
2. Negligible acceleration errors. Acceleration about or along any axis will not be measured as a false input velocity.
3. Wide range of rate measurements. Angular rate measurements over a range of one million to one can be provided with good linearity.
4. Rapid response. A response in the order of 0.005-second and lower can be readily achieved.
5. Long life expectancy. There are no bearings in the device and few moving parts. No adjustments to the sensitive element are required, consequently there is no maintenance problem.
6. Ruggedness. Because of its inherently sturdy construction, the instrument will withstand vibration and shock encountered in the most grueling applications.

▶ Operating Principles:

Basic elements of the instrument are shown schematically in *Fig.* 3. Vibration of the fork tines, continuously and automatically, is produced by electric pickup coils inserted near the moving tips. The signal picked up by the tine pickup coils is

magnetic attraction between the field of the drive coils and the fork tines. The fork will then oscillate at its natural frequency determined by its physical characteristics. The pickup and drive coils merely supply energy lost during each cycle of the fork vibration, making vibration continuous at a constant amplitude.

Torsional oscillations of the fork body during rotation are measured through a vane attached to the heel of the fork, *Fig.* 4. Oscillating motion of the vane between the two magnetic pickup coils generates a signal that alternates at the fork frequency. This signal is amplified and compared to the amplified signal from the tine pickup coils in a phase detector, *Fig.* 5.

The electrical signal from the pickup coils is determined in phase by the motion of the pickup vane relative to the torsion coils. In the case of the reference signal, the phase is determined by the relative motion of the fork tines with respect to the tine pickup coils. The phase detector supplies a dc signal whose polarity is indicative of the relationship between the phases of the two input signals and, consequently, the direction of turn. Amplitude of the signal is proportional to the amplitude of the torsion pickup signal. As a result, the dc signal tells both the magnitude and direction of turn.

The output of the phase detector may thus be used to actuate a meter, as shown in *Fig.* 3, or to control servomechanisms. A servo may be used to drive the instrument itself to approach zero rate of turn as a limit, in which instance a displacement instead of a rate of turn signal is derived.

▶ Application Factors:

Dynamics of the Gyrotron unit differ from the conventional gyroscope in several ways. Where a high rotational velocity is necessary in a standard gyroscope to achieve forces large by comparison to the retarding frictional forces of supporting bearings, the new design has no bearings and develops a signal, that periodically reverses polarity each cycle, requiring only sufficient force to excite the tuned torsion spring. There is no uncertainty threshold and, hence, the minimum detectable rate that may be measured is solely a function of signal stability.

Physical size of the instrument can be subminiaturized with no loss in sensitivity, depending only on the practical limitations of mass and force utilization. The theory of this subminiaturization indicates that size may be reduced without sacrifice of performance.

For applications that now fall within the scope of the conventional units, the new instrument can be a relatively simple and compact instrument requiring little power to operate. The most interesting and important aspect of future development may be concerned with increasing signal stability and sensitivity to a level suitable for use directly as a long-term navigational reference. Results of investigations to date have not indicated any unsurmountable theoretical limitations to stability and sensitivity. It appears likely that further refinements of the known parameters will place the instrument in the class of high-performance displacement gyroscopes.

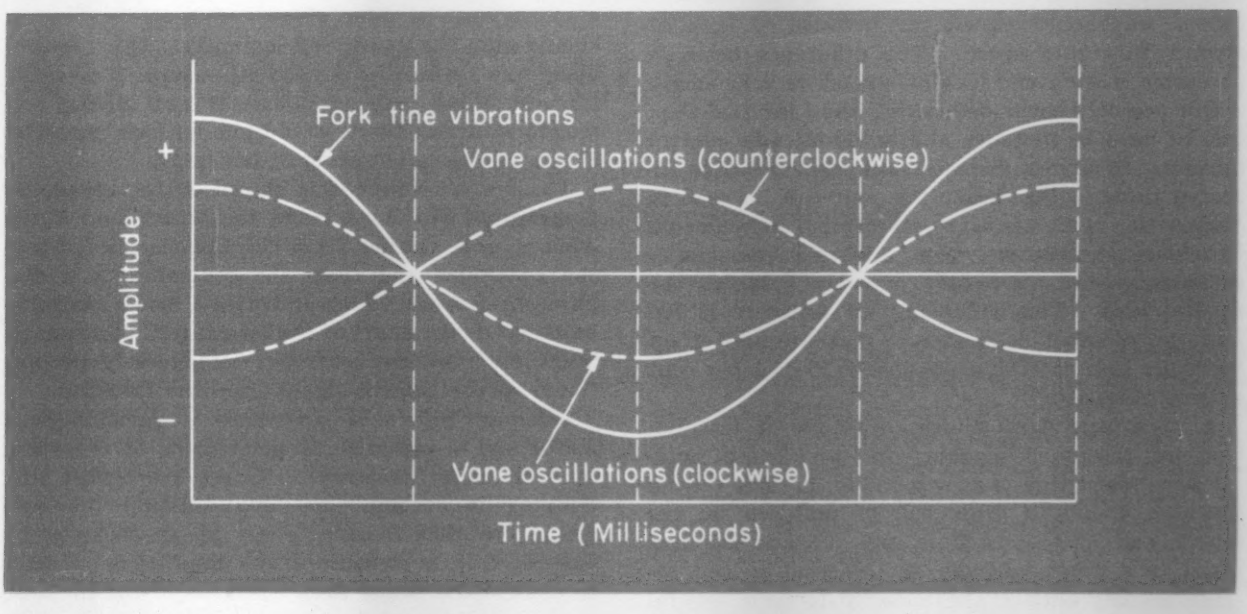


Fig. 5—Comparison of phase relationships between fork tine vibrations and vane oscillations for different directions of turn

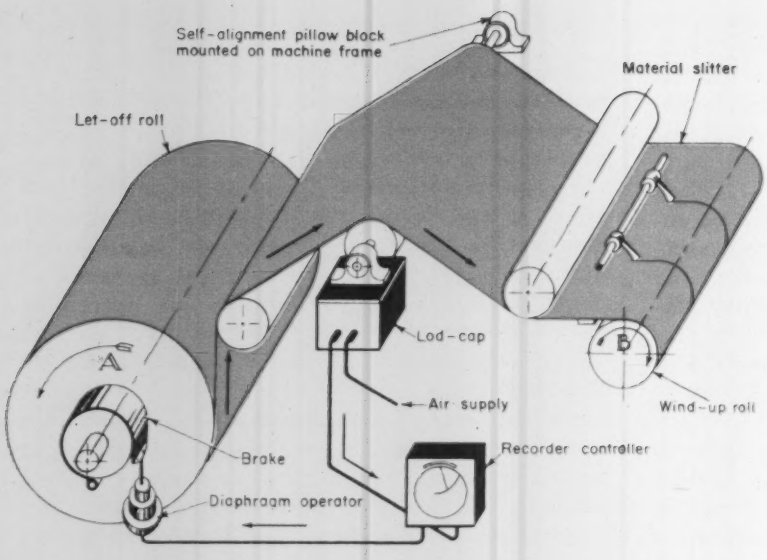


Fig. 1—Schematic diagram of tension control system for polyethylene film manufacture

Direct pneumatic sensing of load permits accurate instrument control in continuous sheet processing

CONTROLLING TENSION

BECAUSE of the continuous increase in the use of commercial sheet products based on the many diversified plastic compounds, it has been found that precise and accurate control of tension in sheet and rolls has become an absolute necessity in manufacture. This is brought about owing to the characteristics of the material and deleterious deformation from excessive stretch which causes washboard effects, or because of lack of stretch to create crush. The difference between excessive stretch and lack of stretch is very small.

One recently developed device, the Link Lod-Cap, can be used to measure and automatically control tension. Of known-displacement pneumatically actuated design, this measuring unit can be used in conjunction with conventional control instruments to achieve automation. The Lod-Cap is continually in balance—the air supply pressure balances the applied load. This balancing air pressure is fed into the recorder controller to measure and effect feedback control with a possible 1/10 of 1 per cent accuracy expected.

A schematic arrangement of a recent installation on a rewind machine for processing polyethylene sheet film is shown in *Fig.* 1. The rewind machine unrolls a large roll of material on the let-off end of the machine and rewinds the material to a given yardage on the wind-up roll, simultaneously slitting the material to form several rolls of lesser widths. The problem presented was to measure and control the tension in the material for the following reasons:

1. To avoid excessive crush of the material.
2. To avoid width reduction from over-tension.
3. To prevent loose winding and loss of the roll core when turned on end.
4. To prevent the combination of these factors resulting in an irregular end pattern because of changes in material width.

An additional requirement was a full-scale cyclic response of 1 cycle per second to permit emergency stop in case of film break. Fall-off in tension should stop the let-off roll instantly. This requirement was especially important because a new let-off roll, being large in diameter and having tremendous inertia force, would pile up loose material if the roll were not stopped instantly.

The system designed is shown on the schematic diagram of *Fig.* 1, *A* being the let-off and *B* the wind-up roll. Output from the Lod-Cap is fed into the controller and from the controller to a diaphragm operator which activates a brake assembly mounted on the shaft of the let-off roll. Pneumatic pressure from the controller is inversely proportional to the control signal from the Lod-Cap.

Wind-up roll *B* is driven by a variable-speed motor and to establish proper tension on the wind-up roll, it is necessary to brake the let-off roll. Braking is accomplished by adjusting the controller, so that tension is set up as required by varying the air pressure in the diaphragm operator to control the brake load. Success of the installation lies in the high response rate realized which makes it possible to adjust the reset rate to eliminate hunting and still permit adjustment of the proportional band to maintain control. Typical response rate of three cycles per second is unaffected by controller line lengths up to 12 feet.

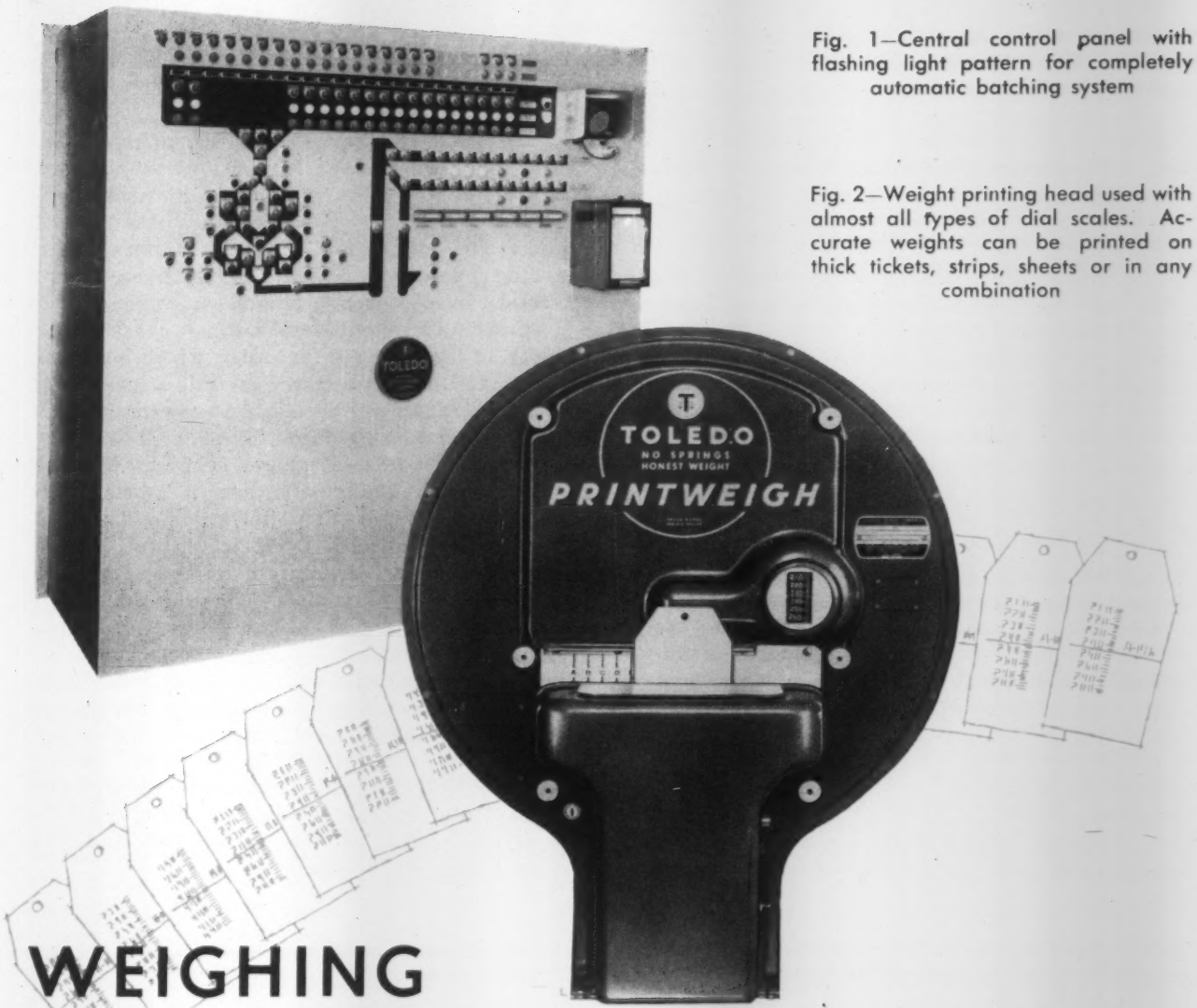


Fig. 1—Central control panel with flashing light pattern for completely automatic batching system

Fig. 2—Weight printing head used with almost all types of dial scales. Accurate weights can be printed on thick tickets, strips, sheets or in any combination

WEIGHING AUTOMATICALLY

Highly accurate quantitative control is possible by means of weighing principles

SCALES and a variety of highly specialized equipment based on weighing principles are making a vitally important contribution to the application of automation techniques. Weight, as it has down through the ages, provides a basis for a highly accurate quantitative control—and today contributes in an increasing degree to the control of quality and the maintenance of standards. New advances in weight control engineering have resulted in production speed-ups, and even greater accuracy.

Human errors are eliminated through the use of automatic controls. One man seated at a central control panel, for example, can set off a whole sequence of events. By conveniently observing a flashing pattern of lights, *Fig.* 1, he can trace the precise operation occurring at any given time. This principle is frequently applied to batching operations; electrically interlocked controls provide for full automation in product processing. Each ingredient, at the proper phase of the operating cycle, is thus quickly discharged electrically to an eventual common mixing area—all through error-free, pushbutton control.

To speed up assembly techniques, "machine judgment" is often employed in automatic parts selection. Such a machine, the dynamic classifier, is used where unusual speed and high accuracy are required. Uniform parts (such as automobile pis-

Article courtesy Toledo Scale Co.

ton rods) are automatically separated into several weight categories. As each individual piece moves over the "live" section of a conveyor system, it passes through a number of photoelectric beams of light—the exact number of beams through which it passes being determined by the weight of the piece. This results in actuating electronic controls which divert the rods into as many as eight different weight channels, including a reject channel. Speed of the conveyor belt is primarily determined by the length of the product being classified.

The continuing flow of raw material to finished product need not be interrupted by the stoppage of production machinery. Nondestructive testing permits 100 per cent inspection without costly shutdowns. In cases where extreme uniformity of stock is necessary, continuous weighers provide an automatic check on conveyor-fed stock to determine whether it is within narrow tolerance limitations. "Over-Under-Zero" scales quickly indicate whether the material weighs more or less than the preestablished weight. If the stock does not fall within the exacting tolerance requirements, automatic controls cause an audible or visual signal to operate—a warning for machine adjustment without machine interruption.

As finished products come along, no man is needed to check them individually. Management is protected against "short fills" and other inaccuracies by means of carton checkweighers. As the filled containers move along a conveyor system, they are automatically weighed to discover whether they meet predetermined weight requirements. If not, they are rejected from the line, while those meeting the specifications move on.

In all the steps of manufacture accurate records must be maintained—records for production, records for the laboratory, records for accounting, records for the shipping department, *ad infinitum*. To establish the exact histories required, two important weight recording devices have been conceived—the graphic recorder and the weight printer. The former has particular application in weighing operations which are relatively slow; the latter, in all types of general weighing, *Fig.* 2.

To create a "weight versus time" chart is the purpose of the graphic recorder which provides an accurate and automatic record of weighing operations. It can be referred to at any time, either during the actual weighing cycle or at a later date.

The widespread use of weight printing machines in almost all weighing situations is ample testimony to their effectiveness. Both the producer and the buyer are protected by their faithful, permanent reproductions of accurate weight figures indicated on the weighing dials. Thus—by machine—is eliminated the mental fatigue inherent to human reading, recording, and remembering which inevitably results in errors.

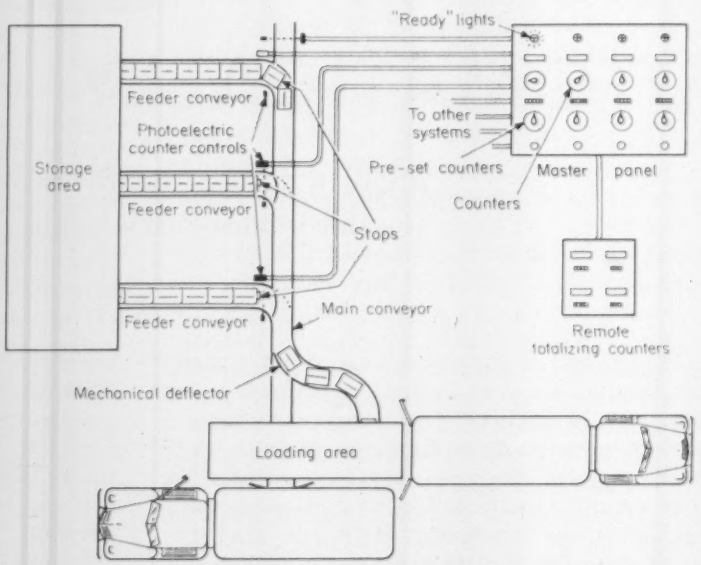
Other myriad applications stemming from measurement by weight are being employed or developed to solve new industrial problems. The role of weight control as a basic factor in speed, ease, accuracy, and reduced production costs lend to it a natural quality of fundamental importance to its integration with automation.

Pushbutton Control Fills Orders

A MODERN BREWERY handling thousands of cases of beer and ale daily has the problem of filling orders accurately and moving them swiftly from storage areas to waiting trucks and trailers. Nature of the operation from storage to the shipping dock calls for centralized control.

Main conveyors run from the storage to the shipping area. At the storage end, main conveyors are fed by a number of feeder conveyors, each of which carries cases of a specific type of beer or ale. Each feeder conveyor is equipped with Photoswitch photoelectric control at the junction with the main conveyor. When a case passes through the beam, the photoelectric relay operates two electromagnetic counters. One is a simple totalizing counter, the other a predetermined counter. Counters for all lines are grouped at a master control panel, so that one operator can supervise the count for any line.

Upon receiving an order, the operator sets the dial of one predetermining counter for the number of cases of a given type. By remote control he opens a deflector to route the cases from the feeder to the main conveyor, then pushes a "start" button to operate the selected feeder conveyor. When the required number of cases pass the photoelectric light beam, the predetermining counter stops the conveyor and lights a control panel lamp, indicating that this part of the order has been completed. This process is repeated for each type of case ordered by selecting proper feeder conveyors and counters.



Recognizing the need for a standardized language in the field of automatic control, the Terminology Committee of the Industrial Instruments and Regulators Division of ASME is actively engaged in listing, defining, and illustrating terms used in process control engineering and related fields. As the first of a series, AUTOMATION presents the automatic controllers section of the ASME standard "Automatic Control Terminology"

AUTOMATIC CONTROLLERS

AS THE RESULTS of automatic installations become more widely known, the techniques of automatic operation are more in demand; the principles of automation are gaining widespread application. This growth of interest accentuates the requirements for a common language of terms, symbols, and diagram techniques. Men in all phases of industry are aware of the need for standards and wish to avoid the confusion that can result when definitions are not clearly established, or when a given term or symbol means different things to different people.

One phase of automation that has already received attention with regard to standard terminology is the area of automatic control. In preparing their standard on this subject the Terminology Committee of the Industrial Instruments and Regulators Div. of the ASME has maintained co-ordination with the allied functions of the AIEE and the Nuclear Energy Glossary Committee of the ASME and consulted the terminology as prepared by the British Standards Institute. The definitions apply to mechanisms and elements which perform their designed functions perfectly, except for terms directed specifically to concepts (i.e. accuracy) involving degree of imperfection.

Automatic controllers are here considered to be only those devices constructed and capable of being used in such a way that the complete installation, including as an essential element the process under control, constitutes a closed loop of action and counteraction operating without human aid. Some phenomenon of the process, called the controlled variable, produces an initial effect upon the measuring means of the automatic controller. If this effect does not correspond with the value of the controlled variable which the automatic controller operates to maintain, the measuring means institutes corrective action. The corrective action operates to restore the value of the controlled variable to the desired value. Unless this entire loop of initial action and corrective action is present, automatic control is not realized. Any thing less than this constitutes some form of automatic operation, rather than automatic control.

101. An AUTOMATIC CONTROLLER is a device which measures the value of a variable quantity or condition and operates to correct or limit deviation of this measured value from a selected reference.

An automatic controller includes both the measuring means and the controlling means. True automatc control systems always contain one or more feedback loops at least one of which includes both the automatic controller and the process.

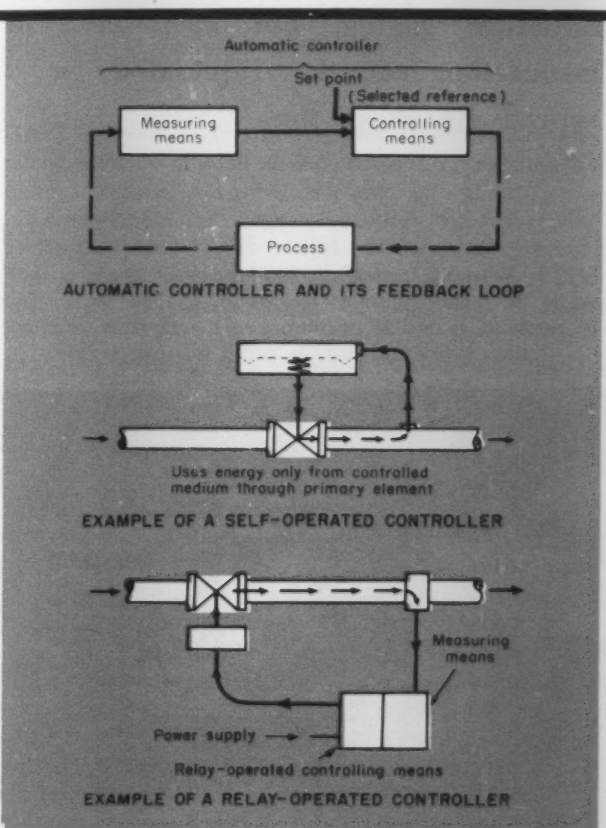
101a. An AUTOMATIC CONTROL SYSTEM is any operable arrangement of one or more automatic controllers connected in closed loops with one or more processes.

102. A SELF-OPERATED CONTROLLER is one in which all the energy to operate the final control element is derived from the controlled medium through the primary element.

This type of controller must have both self-operated measuring means and self-operated controlling means.

103. A RELAY-OPERATED CONTROLLER is one in which the energy transmitted through the primary element is either supplemented or amplified for operating the final control element by employing energy from another source.

This type of automatic controller may have either a self-operated measuring means and a relay-operated controlling means, or a relay-operated measuring means and a self-operated controlling means, or a relay-operated measuring means and a relay-operated controlling means.



AUTOMATIC CONTROLLER AND ITS FEEDBACK LOOP

EXAMPLE OF A SELF-OPERATED CONTROLLER

EXAMPLE OF A RELAY-OPERATED CONTROLLER

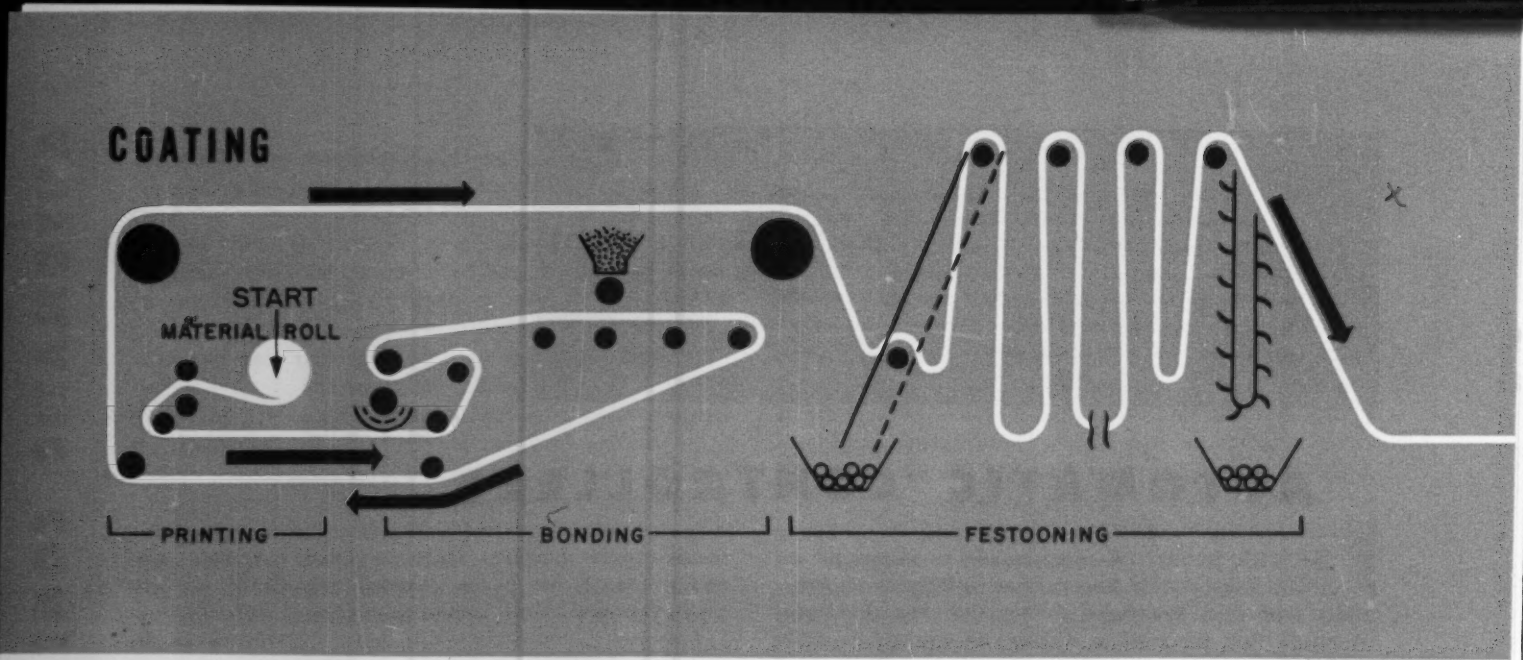


Fig. 2—Flow sketch of coated abrasive making machine. Drying racks after the coating and sizing operations can accommodate up to 12 miles of material. System as shown represents about $1 million investment

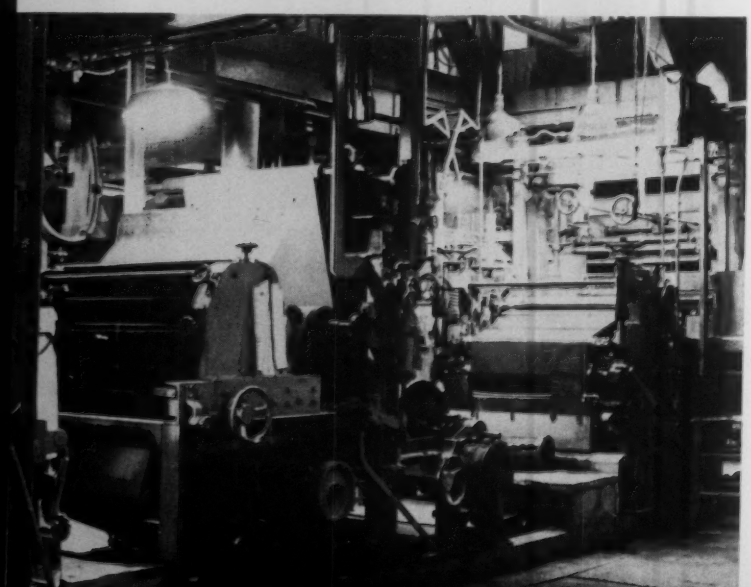
CONTINUOUS GAGING

WITH ATOMIC ENERGY . . .

Not only is it possible to control the product within narrower tolerances by radiation gaging, but also, cost of installation can be liquidated in a suprisingly short time

By E. W. BRATTON
Manager, Product Engineering and Quality Control
Coated Products Division, The Carborundum Co.
Niagara Falls, N. Y.

Fig. 1—View of a making machine that coats a web up to 36 inches wide at speeds up to 350 fpm. Roll of backing material, printing press, adhesive application rolls, and gravity grain fall are visible



PRODUCTION CONTROL in the continuous process line often requires a complete stop in line operation to permit accurate sample gaging. When production rate is more critical than quality, skill of a trained operator may be used to detect product changes in the moving line. Desire or necessity to avoid contact where the product may be moving too fast, temperature excessive or material too soft, has led to use of radiation as a means of automatic gaging, replacing both sampling and "educated guess" methods.

Automatic nuclear gaging has been applied to production control in manufacture of coated abrasives, *Fig.* 1, most common being household sandpaper. Abrasives such as flint, emery, silicon carbide, aluminum oxide, garnet, crocus, and cork in particle sizes ranging from 0.0006 to ⅛-inch are coated on paper, cloth fibre, and combinations of these materials bonded with glue, resin, and varnish. In addition to these variables is density of abrasive grain coating—closed or open coat.

Many problems encountered in obtaining reproducible uniformity of product are complicated be-

Article based on talk delivered at the 2nd Annual Conference on Atomic Energy in Industry, October, 1953.

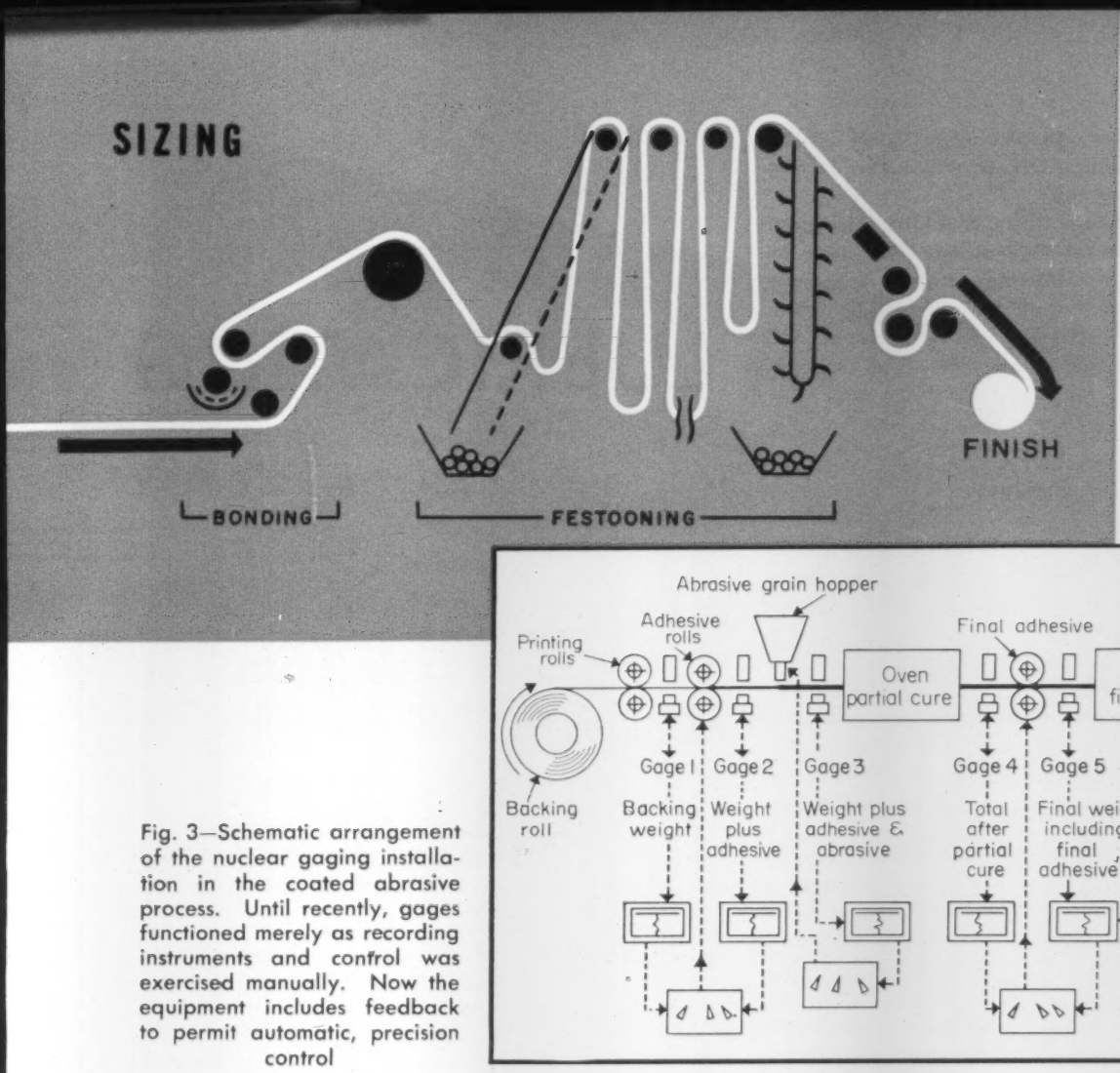


Fig. 3—Schematic arrangement of the nuclear gaging installation in the coated abrasive process. Until recently, gages functioned merely as recording instruments and control was exercised manually. Now the equipment includes feedback to permit automatic, precision control

cause control must be exercised in the continuous process line, *Fig.* 2. A layer of adhesive is calendered on one side of backing material and while still tacky, abrasive grains are oriented and imbedded. When the web is partially dried, another adhesive application is made to anchor abrasive grains, and the product is completely dried and cured. Well-oriented abrasive coating is essental.

Application of abrasive grain is done by gravity or electrostatic charge; grains are lifted off a carrier belt and imbedded in the web, oriented by the force of an electrostatic field.

Until recently, process control has been on a cut-and-try basis, stopping machines every 1000 yards or so and manually cutting samples. Five weight samples were taken at five different locations in the processing line. Between weight sample stops, trained observers attempted to detect and report product changes.

▶ Beta Ray Inspection

Obvious shortcomings of this method led to consideration of radio-isotopes, free from conventional limitations and not seriously affected by external influences such as moisture and dust present around coated abrasive making equipment.

Arrangement of gages installed by Industrial Nucleonics Co., *Fig.* 3, results in complete production control through continuous sampling. The first gage measures weight of backing and thus serves as a check on the laboratory; second gage measures backing plus adhesive; third gage measures backing plus adhesive plus abrasive; fourth gage measures the same elements as the third, except that material has passed through the festooning rack and has lost most of the adhesive solvent; fifth gage measures additional weight of the adhesive applied at the sizer. Each of the five gages can be positioned at any spot across the width of the web giving previously unavailable information regarding cross-the-web adjustments.

Using a beam of high-speed electrons or beta rays emitted by radioactive stronium 90, the gage measures radiation penetrating the sheet which is inversely proportional to the mass of material in the measured area, the same information obtained by weighing a sample of known area in a balance. Electrons reaching the detector ionize a gas

in a special chamber, producing a tiny control voltage that, when amplified, provides the recording and controlling signal.

In normal operation of the machine, the gage is automatically standardized at one-half hour intervals, hence recalibration is seldom necessary. The radiation source has a half-life of 25 years and presents no serious replacement problem. Signals from the gages are translated into a trace on pen recorders.

Improvement in Product

Nuclear gages were first operated with the recorders covered, and adjustments made as previously. After that, recorders were uncovered so that operators could see the traces and make adjustments accordingly. Traces before and after beta gage control were analyzed, revealing variations in product previously unsuspected and excellent prospects for dependable production control. Adhesive weights varied as much as 10 per cent between weight stops, without being noticed by inspectors. With beta ray control it was demonstrated that the variation could be held to plus or minus one or two per cent. Measure of backing plus adhesive plus abrasive showed that with an increase or decrease in adhesive, a similar increase or decrease in abrasive was encountered, compounding the deviation from standard. Examination of the traces made during the trial period also confirmed suspicions of certain mechanical defects which had not been established previously.

The beta ray gage instruments have been in daily use for more than a year and engineers summarize results as follows:

1. Saving of about $13,000 in material that would have been wasted through stop marks and sample cutouts necessary with previous methods of process control.
2. Estimated savings of $12,000 due to reduction in machine downtime for sampling and maintenance.
3. Increased efficiency in raw material utilization, an estimated $45,000 saving.
4. Reduction of inspection personnel costs of about $7500.
5. Increased operating speed resulting from the ability to adhere more closely to specifications, estimated at $4000.
6. Reduction in rejections of about $15,000.

An intangible advantage, certainly oustripping others, is improvement in product uniformity and reproducibility obtained.

Gages have more than paid for themselves in their first year of operation. Satisfaction with their performance is evidenced by the fact that installation of radio-isotope gaging equipment is being continued.

LUBRICATING AUTOMATICALLY

Application of the right lubricant in proper quantity and timing is a must for successful automation

By L. C. ROTTER
Chief Engineer
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EVIDENCE OF PROGESS in the trend towards "automaticity," as measured by the extent to which automatic controls supplant manual effort and human discretion, is being constantly encountered today. However, to design and install a series of machine units with the necessary controls so as to automate a particular production operation is one thing, but to insure its continuous and efficient operation, free of needless machine down-time for lubrication or replacement of worn bearings and parts caused by inadequate lubrication, is another and most vital consideration.

Lubricant application, planned as a functional part of industrial lubrication, must provide for the automatic, precise and dependable controls essential to automation. Such controls are incorporated in the modern automatic centralized system, *Fig.* 1.

This method of lubricant application, and only this method, fulfills the five requisites necessary for efficiently serving the bearing requirements of any automated production operation. These requisites are as follows: (1) A system which permits automatic, controlled application while machines are operating so that plant operating executives can more accurately predict the output per time unit (day or week); (2) a system which will permit interchangeability of machine units without changing the lubrication system on the machines; (3) a system that will maintain a constant film of lubricant on bearing surfaces, thereby eliminating

Fig. 1—Lubricant application throughout the Hanna preparation plant is controlled from this master panel. Top half of the panel is devoted to lubrication controls, indicators and chart recorders reflecting lubricant cycles and pressures. Red signal lights for each section of the plant warn of any variation from normal operation of lubrication system

excessive wear and misalignment of moving parts responsible for a high level of rejects; (4) a system that helps increase machine output to a uniform maximum consistent with work done; and (5) a system that is sealed from lubricant supply to all points of application, thereby eliminating contamination of lubricant, and spoilage of work in process caused by seepage of excessive lubricant.

There are several almost spectacular examples of how mass centralized lubrication, automatically controlling the quantity and time intervals of application, make possible true plant automation. The new $5,000,000 preparation plant of the Hanna Coal Co. near Adena, Ohio, is particularly notable. Here, application of lubricants is automatically provided to bearings on an exceptionally wide variety of cleaning and processing machinery. Lubricant is supplied from three stations by power operated, time clock controlled pumps through 18,000 feet of supply line laid beneath concrete floors to circuits of lubricant measuring valves on each bank of machines. The entire system is controlled from a master panel incorporating both pressure and cycle recorders, *Fig.* 1.

It becomes quickly apparent that the development of plant automation is necessarily dependent on a corresponding automation of lubricant application. There is no place in this new industrial era for the "grease monkey" with his oil can. Four essential facts regarding the lubrication function must be recognized if the multiple benefits available through controlled appplication are to be obtained:

1. Highest quality oil or grease, regardless of cost, cannot become a lubricant until applied to a bearing. Therefore, provisions for the application of lubricant should take precedence over the selection of a lubricant.
2. Application of lubricant to maintain bearing surfaces, is a distinct operating function and should not be confused with general maintenance.
3. Conditions within modern industry today present a situation entirely new and far afield to those existing when the application of lubricant was so simple that the conventional oil can and grease gun embodied all provisions requisite to proper application.
4. These new, modern conditions are of such magnitude and complexity that the inherent deficiency of individual contact methods cannot be made to suffice, even though supplemented by elaborate record keeping, detailed lubrication instructions and check procedures, as has become common practice under routines established as "preventive maintenance."

Provisions for the application of lubricant can be deemed adequate under all conditions and in all respects when, and only when, they apply the right lubricant in the right quantity at the right time.

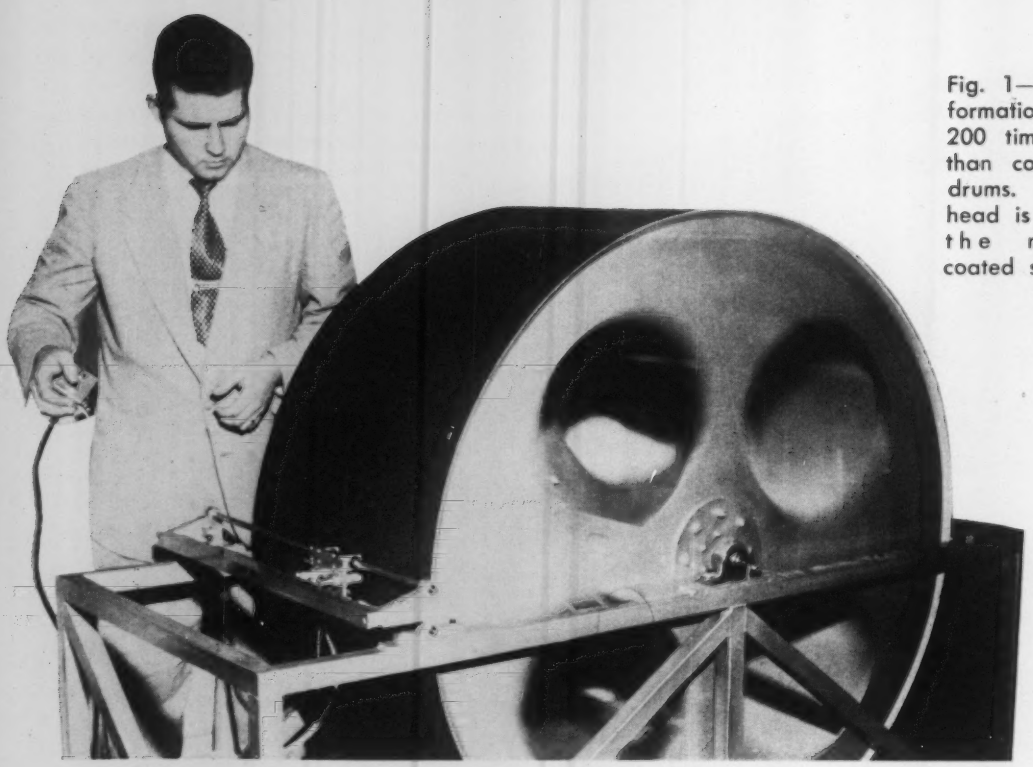

Fig. 1—New air-floating information storage drum has 200 times greater capacity than conventional magnetic drums. Reading and writing head is shown moving over the magnetic - dispersion coated surface of the drum

AUTOMATIC INFORMATION STORAGE . . . .

This electronic computer brings closer complete mechanization of data handling

PROSPECT of completely automating routine accounting and clerical work of modern business has been envisioned since the advent of the first business machines. Large areas of accounting and information handling have been partially automated through use of punched card and similar machines; computer engineers tell us that complete automation is just around the corner. However, beyond our office doors we still hear the buzzing of hand adding machines, the ceaseless drawer clicking of old-fashioned filing cabinets and the same multitude of people carrying papers to and fro. Is the automatic office really at hand or has the automatic accounting machine become bogged down under tons of its own punched cards?

Information Storage Systems

All accounting procedures or information storage systems may be classified into two distinct systems, the serial system and the random system. Failure to recognize these two systems and the fact that in most businesses both are equally necessary, may have led planners of business automation far astray.

A serial information storing system is one in which the list of entries is of indefinite length and items are not subject individually to future modification. Perhaps the simplest illustration is the bookkeeper's journal which contains a chronological list of transactions, or a tape which has been run to prove a bundle of checks passing through a bank. A significant characteristic of all serial systems is that one must sort through the entire list, tape, or stack of cards in order to find any particular item or all of any class of items.

A random system is one in which the number of items is relatively constant but each item is subject to periodic additions and modifications. Examples might be the accountant's ledger, files of customers' accounts, inventory records, or a list of available seats on a train. A significant characteristic of all random systems is random access; that is, rather than search through all items, a specific page, a specific account or stock number would contain a current balance or such other pertinent information.

Punched tape or cards, magnetic tape, reels of microfilm, and many other devices in use are readily adaptable to serial systems and they have been highly automated. Much recent engineering on business machinery has been an attempt to adapt serial type machines to random type requirements. The fact is that this cannot be done.

A serial system is essential for auditing, location of errors, and as a permanent or semipermanent record to support invoices and the like. However, it is from the random type system that financial reports are made, estimating and future planning done. While use of machines on serial systems has effected great economies, impact on efficiency and success of business operation with complete automation in random systems will be even greater.

Although present automatic office systems have made great strides in elimination of costly and tedious office work a recent development in the magnetic memory drum opens new areas for automation in random systems

▶ Information Storage Devices

Principal reason why random systems have not been made automatic is simple—until now there has been no practical way to do it. Although there are many ways of storing information for electronic or other automatic processing, there has been no way of having random access to a sufficiently large store of information.

Probably first attempts at automatic random access came with the automatic digital computers. A whole family of new information storage devices was developed, all having high-speed random access. Examples are electrostatic storage tubes, ultrasonic delay lines, magnetic drums, magnetic cores and large banks of vacuum tubes. Some of these systems, such as electrostatic, ultrasonic and vacuum tube storage were volatile—in event of a power failure all information was lost. Magnetic devices were capable of retaining permanent records but shared the disadvantage with other random access devices in that capacity was small. Internal random access memory of even the largest modern electronic brains can store only a few pages of printed matter.

Of these devices, the magnetic drum offers

. . . WITH RANDOM ACCESS

By GLENN E. HAGEN
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Fig. 2—Input-output station consisting of an electric typewriter with tape punching and reading attachments. At the operator's left is the digital computer control panel, used as part of the library system

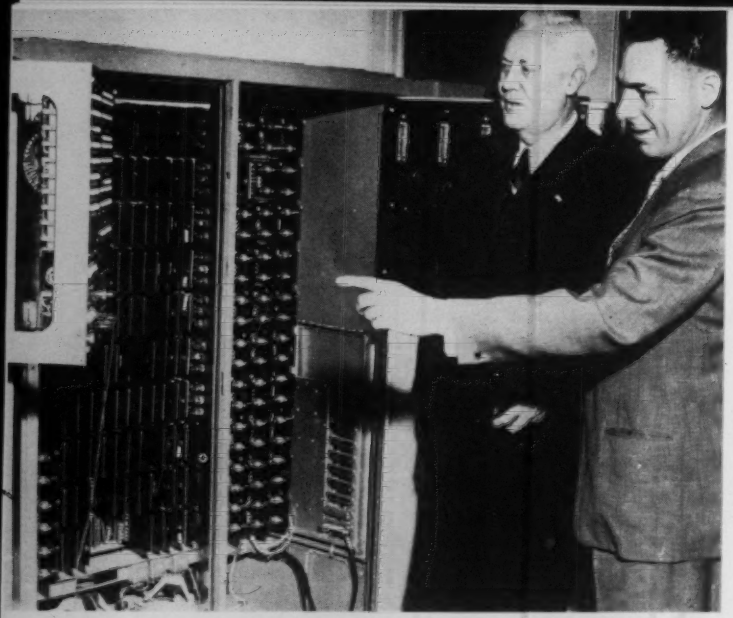

Fig. 3—Author explaining computer operation to Dr. Axel L. Wenner-Gren, Swedish industrialist and development financier of the magnetic library system. This computer, ALWAC, is said to do the work of million dollar predecessors, yet costs considerably less

greatest possibilities. Rotating constantly at high speeds, the drum surface is coated with a magnetic dispersion similar to that of a tape recorder. Electrical heads capable of reading and writing information are positioned at close intervals along the cylinder, and as it spins, each of these heads has access to a small loop of information extending around the circumference of the drum. The assembly can be pictured as a battery of tape recorders wherein each tape is made into a small loop. Rate of spin is so high that heads read and write many thousands of characters per second and are compatible with high-speed electronic processing equipment.

Engineering difficulties and limitations of conventional drums have prevented the magnetic drum from becoming the random access device of business systems. Heads must be positioned rigidly about 0.001-inch from the drum surface in order to read information, and yet if they were to touch the drum surface, both head and drum would be damaged. Due to thermal expansion and other dimensional problems, diameter of the drum is severely limited. Therefore, no great amount of data can be stored in any single channel, and a multitude of expensive heads must be used with their associated switching and amplifying equipment. Also, a traffic problem is involved since most business applications require a large number of input and output points to their store of information. To have any input-output station reach any desired channel of information, some elaborate automatic version of a telephone switchboard is necessary. Net result is that while the conventional magnetic drum is amply reliable and fast, the installation is too expensive both in initial cost and upkeep.

▶ New Simplified Unit

Recent discovery of a simple mechanical device simultaneously has solved the problems of capacity, traffic, and cost. Engineers came up with a simple reading and writing head, shown in *Fig.* 1, that rests against the surface of a high-speed drum, lubricated by a film of air. These heads, instead of being precisely machined and rigidly mounted, are free to move about over the surface of a large drum and quickly locate desired information or make the desired entry. This innovation eliminated the necessity of a separate head for each of many small information loops, and also solved the traffic problem in that each input-output point could have its own private head which would work independently from the others. Still further, ability of these heads to adjust themselves to imperfections in the drum's surface removes previous limitations as to size of drums, presently built of inexpensive sheet metal without precise machining of either drums or heads.

With this new type magnetic drum, a number of input-output stations, one is shown in *Fig.* 2, such as typewriters, teletypes, time clocks and other similar machines can be used, each having simultaneous random access to the entire file of information. Each station can be isolated electronically from all other stations to allow periodic servicing without affecting system operation. Automatic interlock can prevent simultaneous recording of the same item on two stations. Elaborate checking systems can make loss of recorded information virtually impossible. For detailed accounting summaries, it is possible for a special unit to scan the entire "library" and select required information.

Applications of the system reach into almost every field of business. Perpetual inventory systems can be built to show instantaneously not only stock on hand but up-to-date demand and reordering information. Cost accounting can be vitalized by tying the system directly to time clocks. Verification of customer credit, reservations, and compatability with teletype suggest a broad scope of utility.

Computer magnetic-memory drum combinations, *Fig.* 3, can be used in offices for statistical analsis and cost accounting, computation and preparation of telephone, electric bills, and payrolls, keeping insurance policy, social security, and personnel records, making economic studies, management reports, business forecasts, and preparation of budgets. Routine picking and filing, and use of semiautomatic machines can be eliminated.

With the development of new information storage devices, that area of business activity requiring the random system certainly can become as automated as business activity requiring the serial system. The day of complete data handling automation is at hand.

INCREASING AUTOMATION OPPORTUNITIES

No single, simple rule can be used to indicate economic feasibility of automation. New concepts, research and management planning can create the climate and reveal the possibilities

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REMARKABLE ingenuity evident in the design of automatic operations both for shop and office illustrates the ability of men given concepts about which to work and build. However, in the matter of concepts there is considerably less cause for satisfaction. These wonderful things are occurring only in those segments of our industrial activity in which the opportunities are not being created, but already exist. The problem is not technical skills but managerial skills of planning and conceiving — of creating opportunity for technical skills. The attitude seems to be one of testing what is available for adaptability and accepting that as the ultimate rather than creating an acceptable environment by obtaining new concepts of the nature of the operation itself.

Large-Volume Variety Manufacturing

There is no need to ferret out the fact that beverage bottling can be automatic if technical skills are available. In most cases there is ample volume, a high degree of repetition, either in the form of long runs of one product or of a few products requiring the same processing activity and a reasonable amount of manual labor content. The things that must be controlled in such an operation are also not too difficult to visualize. In effect this is a ready-made situation.

At the other extreme there is another typical manufacturing operation that may make and list for sale a half-dozen product lines, each consisting of several thousand distinct models. Such a business also may have a large aggregate volume, as indicated by an order rate upwards of 10,000 or 20,000 units or products per week. In this instance the opportunities for going automatic are not obvious.

On the face of it, this appears to be a business in which the average order rate is about two units per model per week. If, superimposed upon this complexity is a national sales organization ordering in various size lots and with a variety of product mixes from a number of locations, the opportunities for going automatic on a large scale seem fairly dim. As if in proof of this statement there is also little to be read about either large-scale mechanization or automation in this kind of an operation. What is required here first is research in the operation itself for concepts that create the opportunity. A business having large volume and great variety can be examined for concepts that can lead to creating an environment conducive to going automatic.

In the first place the most common concept of high, repetitive and continuous volume of the finished product is not obvious in this case as it is

Based on a paper presented at the Annual Meeting of the ASME, Dec. 1953 in New York.

in the case of beverage bottling, speaking of possibly 10,000 or 20,000 units of product spread over something like 12,000 specific models. A more subtle approach is therefore required in which an analysis may have to be made several levels down from the finished product to ascertain if the environment exists or can be made to exist. Most of these methods are not new. What may be novel is the use of all of them, if required, and taking action as a result across all functional areas of a business; not just manufacturing alone. For purposes of discussion these research activities can be defined by levels, beginning with Level 1, as investigations of the finished product.

Groupings of Finished Product-Level 1

The first approach is the examination of the distribution of the total volume by families of finished products and by individual models. Volume is obviously not evenly distributed over all models and if the situation is examined for some reasonable period of time, as a quarter or a year, a distribution as shown in *Fig.* 1 might well be expected. In this case two model numbers represent 81.7 per cent of the annual volume and 6 models 90.8 per cent. It may be that the first two models in themselves represent sufficient value to permit their consideration for automatic handling alone. Of course, the problem is not solved then. There must also occur a sufficient constancy of use to keep a given quality of specialized manufacturing equipment operating at a sufficiently continual rate to justify installation.

A typical flow of orders on a month-by-month basis for a year in this kind of business is shown in *Fig.* 2. The order rate varies from 2000 to 500 units of products per month. On the face of it, this kind of variation is not conducive to the use of specialized equipment. The utilization could vary from 25 to 100 per cent in the year in question. It would rather suggest putting many products on the machines to level out the peaks and hollows.

Actually, the process of manufacturing and filling orders is a cumulative process. When the order rate is higher than plant capabilities, shipping promises are made longer; e.g., as a backlog is accumulated. When the orders are lower than plant capabilities finished stock is accumulated. The same line of reasoning can also be applied to the problem of the specialized line of machines for a specific product. Assuming a constant rate of output consistent with reasonable payoff, what backlogs of orders and what surplus stocks might be accumulated and for what periods for the product in question?

A plot of the same order rate as in *Fig.* 2 but on a cumulative basis is given in *Fig.* 3. In this case

Model Number	Volume in Units	Cumulative % of Total
8 x 101B	5862	55.0
8 x 101A	2848	81.7
8 x 101DJ	501	86.4
8 x 101BT	181	88.1
8 x 101AS	153	89.6
8 x 101DK	130	90.8
8 x 101C	126	92.0
8 x 101E	118	93.1
8 x 101G	111	94.1
8 x 101AN	84	94.9
8 x 101D	81	95.7
8 x 101AL	71	96.3
8 x 102B	66	97.0
8 x 101Q	63	97.6
8 x 101BB	36	97.9
8 x 103A	27	98.2

Fig. 1—Distribution of volume by model for a 1951 8x100 line. Two models include 81.7 per cent and six, 90.8 per cent of the production

the individual slopes are the monthly order rates. It will be observed that on this basis the overall rate looks like it is pretty close to being a straight line, sufficiently so at least to provide a basis for managerial decision concerning how much finished stock can be tolerated and also what extended shipping time.

Fig. 4 indicates two possible positions that management might elect to take. In *Fig.* 4*a* it is assumed that immediate shipment is always required. In this case we accumulate roughly three-quarters of a month's stock by year end, with substantially less stock on hand than this during most of the year. In *Fig.* 4*b* it is assumed that three weeks' shipping time is acceptable. In this case, the year is ended with about two weeks' stock while during the year there have been only rare occasions when shipment could be made immediately from stock. This illustration merely points out the possibility of operating at a constant rate with as widely fluctuating an order rate as indicated in *Fig.* 2. Such a procedure has its risks that must be evaluated. But a historical performance curve such as *Fig.* 2 need not in itself be a discouragement.

Grouping of Major Components-Level 2

Quite frequently in an operation of this type people discover, usually by accident, that a certain subassembly or part has a sufficiently large usage to indicate that it is used on more than one model of finished product. As a result, those parts or subassemblies are produced independent of analysis of incoming orders on some sort of trend basis. Usually this trend is only vaguely associated with

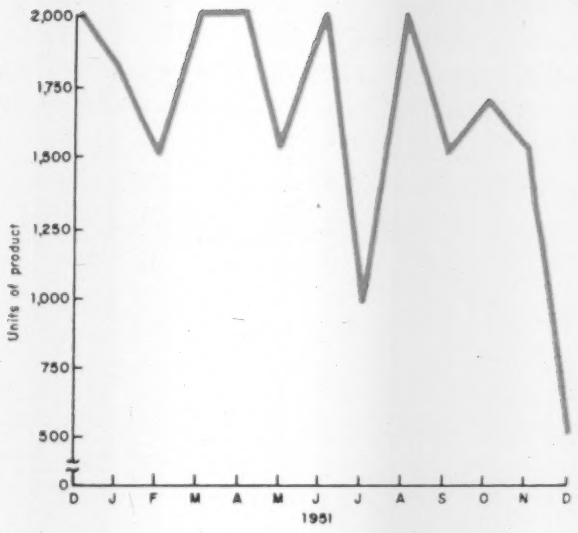


Fig. 2—A typical "orders received" plot by the month for one year

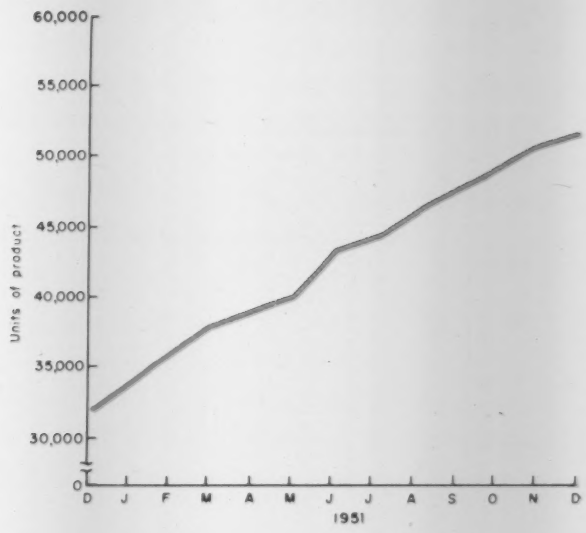


Fig. 3—Plot of same order rate as in *Fig.* 2 on a cumulative basis

the specific models of finished product and finished-product order rate.

This accidental approach suggests that a planned analytical examination of the array of products from the existing engineering documents might lead to a positive base for obtaining sufficient volume and value in components to lead to an environment congenial to automation. This constitutes a second level of analysis.

For example, the array of products illustrated in *Fig.* 1 on analysis indicates a superior pattern in terms of volume for basic operating mechanism than does the array of finished product itself. This is shown in *Fig.* 5. Two things occur as results:

1. There is a larger volume base than in the case of the finished product.
2. There should be a great constancy of requirements for this component since it is used on not one model but 14.

This type of approach to the mechanized machine or line is not without its problems; one of these problems is of course the necessity for matching the components so made with other parts manufactured by traditional methods. This presents an interesting inventory-control problem which is beyond the scope of this article.

▶ Parts to Families of Models-Level 3

In *Fig.* 5 there were present two mongrel operating mechanisms EIIAL and EIIAM. The question naturally arises as to the respect in which they differ from EIIAK. In *Fig.* 1, two basic models 8x101B and 101A represent 81.7 per cent of the volume, yet 14 models in the total array use the same operating mechanism EIIAK so that the same question arises with respect to the finished models. What are the differences and why?

Is so happens that the differences in the mongrel operating mechanism EIIAL and EIIAM and EIIAK are operating voltage. The mechanical mechanisms are the same, the voltage of the energizing coils alone differs. This suggests that the mechanical structures for EIIAL and AM might well be made along with EIIAK.

Examination of the finished models themselves frequently reveals that the differences are in the finishing operations, different combinations of the same parts and frequently human error. It is not uncommon to find 75 per cent of the parts and 90 per cent of the value of a product array is in common parts. Referring to *Fig.* 6, it will be noted that this line 9x100 also uses the EIIAK operating mechanism as does the 8x100 line. A cumulative effect is freqeuntly obtained across existing product lines as well. It is frequently found, too, that such patterns exist but are not developed completely, largely because people have not taken the time to look at the totality of parts at one time and in one place to determine where they are used across the entire array of models being built.

If nothing else, such analytical work suggests partial redesign to make doing the work automatically more feasible. However, the real power in this type of analytical approach, beginning with significantly arranged arrays of finished product and working down to associating these arrays or families with groups of parts, lies in the ability to relate directly a sales forecast or the going order rate to parts. In this manner it is possible

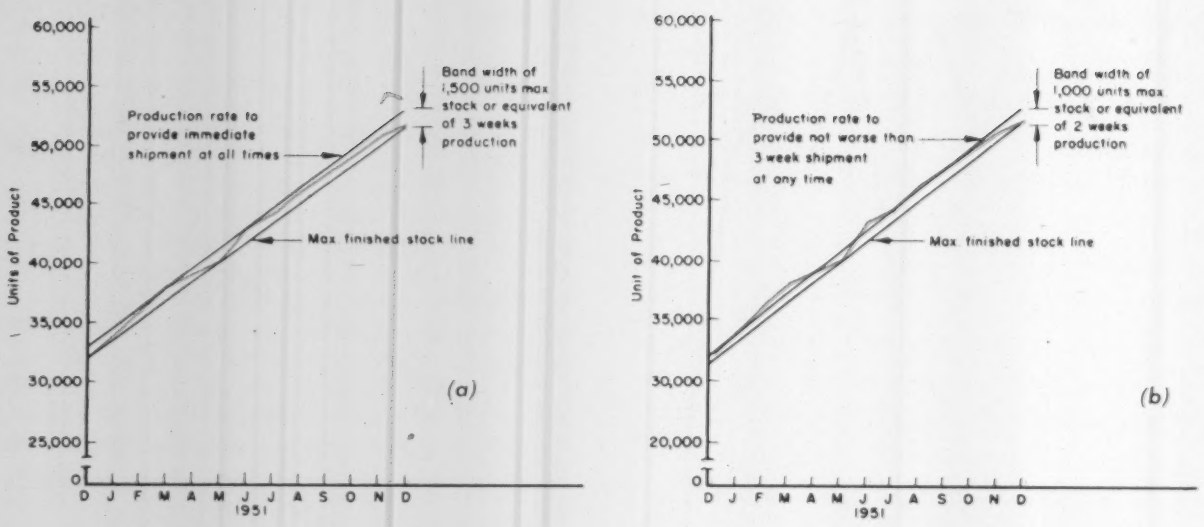


Fig. 4—Relation of a constant production rate based on immediate shipment to orders received is shown at *(a)* and based on maximum of three weeks shipment to orders received at *(b)*

to appraise parts against an order rate and finished-product mix for determining the potentialities in volume and repetition by parts or groups of parts when these factors are not apparent at the finished-product level.

▶ Creating the Climate

Here are then at least three levels at which analytical work upon the operation itself can be done. They are all concerned with discovering whether there is something in the fundamental nature of the business that will provide a climate for doing work automatically. Obviously they also suggest ways rationally of making this climate more suitable. Any evidence of a pattern, even if incomplete, suggest that the business has or is evolving in certain directions. Where some of these things occur, the natural tendency is to help the situation along, if it can be done sensibly.

Observing a situation like that indicated in *Fig.* 6, the natural tendency is to ask marketing people to eliminate some of the offending models. It is in those sold at an annual rate of two or three that the principal variations also occur in the operating mechanism. If this pattern is observed over a period of years the arguments become even more compelling. Yet, it must be admitted that this is the most difficult level at which to assist evolution. Invariably it appears that the entire structure of the business hinges upon these items that sell at an annual rate of two or three. In spite of this emotional difficulty, there is provided by this method a powerful lever for starting change toward simplication.

A more fruitful area is engineering design. There are people who suggest that radical changes may be required in design before the automatic factory is possible. In part this may be true but these are people who look at the finished product only and do not plumb the depths to subassemblies or groups of parts. As previously indicated, when testing a significant group of parts, significant in the respect that they are tied together by a common voltage level, kilovolt-ampere or horsepower rating, interrupting duty, etc., one discovers minor variations from a pattern. Winding insulation for coils being examined, for instance, pieces of insulation were grouped under a combination of significant factors including voltage level, winding mandrel size, overall external build, layers per coil, etc. It was discovered that the pattern for specific pieces was completely random as illustrated in *Fig.* 7. On second inspection it was found that the variations were insignificant fractions of the total dimensions. It also was found that in those instances where insulation for the inner layer was longer than one might have supposed, the insulation for the second layer was shorter, etc.

On discussion with the designers it was soon discovered that they had no concept of the manufacturing and inventory problem they were creating. Seeing the random nature of the results, where any person would have suspected order to exist, they were most willing to change. They were willing to admit that the random lengths resulted from their failure to comprehend other than material costs and the feeling that the workman would trim the insulation anyway while winding.

This is design change too, but by increments. Despite the fact that this represented only a small

Model Number	Cumulative % Total	Operating Mechanism	Accumulative % Total
8 x 101B	55.0	EIIAK	55.0
8 x 101A	81.7	EIIAK	81.7
8 x 101DJ	86.4	EIIAK	86.4
8 x 101BT	88.1	EIIAK	88.1
8 x 101AS	89.6	EIIAK	89.6
8 x 101DK	90.8	EIIAK	90.8
8 x 101C	92.0	EIIAK	92.0
8 x 101E	93.1	EIIAK	93.1
8 x 101G	94.1	EIIAK	94.1
8 x 101AN	94.9	EIIAK	94.9
8 x 101D	95.7	EIIAK	95.7
8 x 101AL	96.3	EIIAK	96.3
8 x 101Q	97.0	EIIAK	96.9
8 x 101B	97.6	EIIAK	97.2
8 x 102B	97.9	EIIAL	97.9
8 x 103A	98.2	EIIAM	98.2

Fig. 5 —(Left) Superior pattern of the operating mechanism EIIAK for the 8x100 line of units. Operating mechanism has one model equalling 97.2 per cent of the total and in complete models, two representing 81.7 per cent and six representing 90.8 per cent

Model Number	Volume In Units	Operating Mechanism	Model Number	Volume In Units	Operating Mechanism
9 x 100A	7890	EIIAK	9 x 106A	15	EIIAR
9 x 101A	3420	EIIAK	9 x 100C	12	EIIAK
9 x 100AV	1540	EIIAK	9 x 101B	10	EIIAK
9 x 100G	356	EIIAK	9 x 102G	6	EIIAK
9 x 100D	119	EIIAK	9 x 100AJ	4	EIIAL
9 x 102F	56	EIIAK	9 x 100K	2	EIIAL
9 x 100B	43	EIIAK	9 x 100P	2	EIIAJ
9 x 100AY	40	EIIAK	9 x 100BA	2	EIIAM
9 x 107B	26	EIIAK	9 x 100BG	2	EIIAM
9 x 101G	25	EIIAK	9 x 100AJ	2	EIIAM
8 x 101H	22	EIIAK	9 x 100AM	2	EIIAP
9 x 101D	21	EIIAK	9 x 101W	2	EIIAP
9 x 100BJ	21	EIIAK	9 x 100AF	1	EIIAP
9 x 100N	20	EIIAK	9 x 100BC	1	EIIAL
9 x 100T	19	EIIAK	9 x 100BR	1	EIIAJ
9 x 101N	18	EIIAK	9 x 100CF	1	EIIAR

Fig. 6—(Right) Distribution of volume by model for a 1951 9x100 line of units

change in design it created a much more congenial atmosphere for the manufacture of insulation. In fact, by assuming the winder would trim, the engineers were actually preserving an environment for manual work. The absence of patterns or the existence of partial patterns should be accepted as an opportunity for directing effort toward the creation of the correct environment not as a deterrent to going automatic.

The Concept of Value

In the earlier examples the concept of volume has been heavily stressed as an environmental factor. Volume only is not necessarily a good guide. A more definitive guide is value, which in general terms is a product of volume and the labor involved in making a given part of subassembly manually. Value has a two-edged effect. In some instances it may discourage the automatic approach even when volume is available; in others it may encourage the use of this approach even though large volume is not available.

With a simple punched part that can be produced at the rate of 100 minute, if the annual usage is one million, it is quite likely that a specialized machine would not be in order as it could provide the annual requirement in roughly twenty working days. This would more than likely be planned for a general-purpose press with effort perhaps directed toward simplifying the set-up. In this instance, although volume is high, the aggregate value is low when measured in dollars or time.

By contrast there may exist a low-volume item with high value as a result of the labor content, both running and set-up, that may well dictate a continually operated specialized process. The absence of volume alone does not necessarily indicate that the enironment is not right for going automatic. In fact there is available a reasonable body of operational research mathematics that may assist in making such determinations.

Concept of the Value Control

In the foregoing it was suggested that the large volume-great variety business that was used as an example might show the following characteristics:

1. Groups of significant parts that can be associated with specific models of finished products.
2. A variable order rate in which the degree of variation was sufficiently small to merit taking the risks of operating at a fixed rate for long periods of time.

Another pattern that may be discovered is as follows:

1. Groups of significant parts that can be associated with specific models again are discovered.
2. The degree of variation in the order rate is too great to risk operating at a constant rate or the product mix varies significantly.

This type of pattern suggests the general-purpose shop. However, as was pointed out earlier, in analyzing models against parts, it is frequently discovered that there are certain parts, usually of limited number, that really define the product

Coil Specification	491-1	465-3	465-2	491-2	655-1	347-1	347-2	485-1
Voltage Class	7200	7200	7200	7200	7200	7200	7200	7200
Mandrel Size	3"	3"	3"	3"	3"	3"	3"	3"
Coil Height	5	5	5	5	5	5	5	5
Coil Build	1½	1½	1½	1½	1½	1½	1½	1½
Layers Per Coil	3	3	3	3	3	3	3	3
Layer Insulation								
Layer 1 KP 5"x	10	10¼	10⅜	10⅛	10	10¾	10¼	10⅜
Layer 2 KP 5"x	12	11⅜	11¾	11¾	11⅞	11⅝	12	12⅛
Layer 3 KP 5"x	13⅞	14¼	13¾	14	14	13⅞	14⅛	14⅛
End Insulation								
Layer 1 PB ¼"x	10⅛	10⅛	10¼	10¼	10⅜	10⅛	10⅜	10½
Layer 2 PB ¼"x	12	12⅛	11¾	12⅛	12¼	11⅞	12	12¼
Layer 3 PB ¼"x	14	14¼	14⅛	13⅞	13¾	14	13⅞	14

Fig. 7—Listing of coil insulation pieces showing random pattern discovered

family. On these definitive parts there is no opportunity of playing with the laws of chance assuming that if one family is low, another will be high. These definitive parts must be available otherwise the operation lacks flexibility. These parts may be of only relatively high value.

In this case the managerial decision for automation may be based upon its use to obtain a planned type of flexibility. The arithmetic in justification in this case is concerned with the cost of idle machines against loss of business due to inflexibility and the cost of carrying inventories of these definitive parts in sufficient quantity reasonably to cover the expected band widths of order-rate variation.

Bringing Tools to the Machine

Another type pattern may develop in this type of business. In this case:

1. The parts fall into significant patterns that can be related to models of finished product.
2. The order rate shows a reasonable constancy.
3. The value of individual parts is such as to suggest the ordered accumulation of parts inventory as the most economical procedure.

Here the answer is obviously a shop filled with general-purpose tools and the separation of parts manufacture from assembly operations by a planned buffer of inventory. The constancy of the order rate over long periods, as illustrated in *Fig.* 4, suggests a fixed schedule for the parts shop mathematically analyzed for an optimum utilization of the machines at any time.

In this case although the machine tools are general purpose, the set-ups on these machines should pass across them in a regular, planned sequence. This suggests the automation of the set-ups to the machine rather than the automation of the flow of material to specialized machines.

If one wishes to be just a bit visionary, it seems entirely feasible that the fixed schedules of parts ultimately might be stored on a magnetic-drum memory and that the reader on this computer could send control messages to the conveyors carrying the set-ups consistent with the preplanned schedule. There is here the problem of losses which in a mature business should be capable of resolution by statistical methods.

Conclusions

The intent of these observations has not been to give a complete and definitive listing of approaches to the problem of automation. It is also not intended to create the impression that a way can be found to do all jobs automatically. Its intent is rather to stimulate interest in probing beyond the obvious. To find patterns and relations at one of a number of levels within the operation. To do research in the operation to find the existing climate in which automatic manufacture is feasible or as the means for creating such a climate without revolutionizing the product or the market; and then to utilize the type of climate discovered in designing the automatic approach.

The desire has also been to show that the problem is not limited to the fields of engineering and design but that it must include the managerial functions of concept forming, planning accordingly and the evaluation of risks.

If we will look beyond the obvious and utilize the analytical tools now available, the opportunities for mechanization and automation should be surprisingly increased.

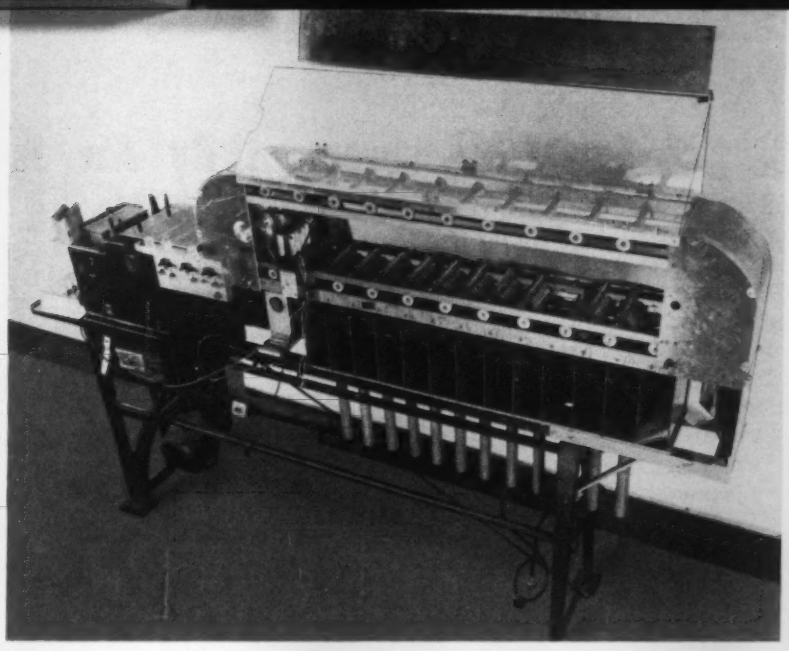


Fig. 1 — Automatic conveyor belt sorting machine designed with ten pockets for cards

AUTOMATIC SORTER

employs system suitable for components, papers and other items to be examined and separated

A MACHINE for automatically sorting physical objects into a large number of categories recently developed by the National Bureau of Standards, *Fig.* 1, will handle punched cards at a rate of 420 per minute. The principle, however, is applicable to sorting such other objects as mail, electrical and mechanical components, and even farm produce as well as checks, invoices, and other papers. Any items that can be separated into a number of subdivisions can be handled by an electromechanical system similar to the NBS sorter.

Objects to be sorted are examined at one station, fed into a conveyor and simultaneously a mechanical address number is put into each section of the conveyor belt so that the object and its address number travel together. When the object reaches the correct address, or location, a simple recognition device is excited, and the object is removed from the conveyor. The machine consists of five major components: (1) A sensing unit that reads the data cards and determines where they should go; (2) an addressing device that loads the conveyor with the cards and their corresponding address numbers; (3) a conveyor belt that carries both the card and its address number; (4) a series of recognition devices, actuated by the information-bearing mechanism of the conveyor belt, which operates trip mechanisms so that the cards are released from the conveyor; and (5) a series of

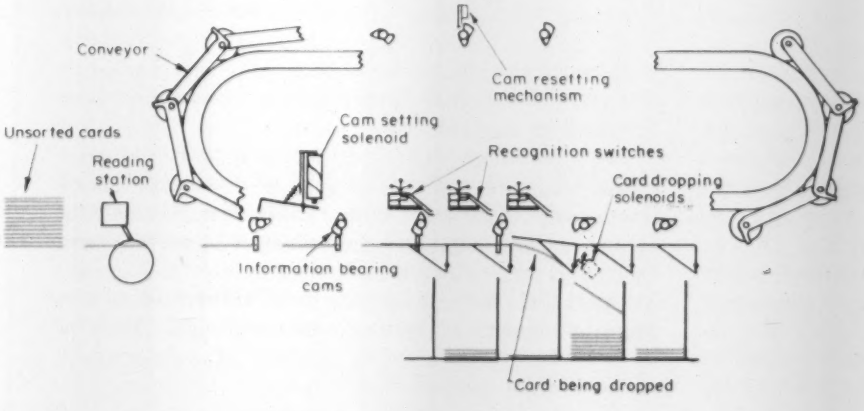


Fig. 2—Schematic diagram of conveyor belt card sorting machine. When the recognition switches are actuated by the cams on the conveyor the card is dropped into the pocket below

receptacles, or gates to other devices, into which the material borne by the conveyor is sorted.

The machine contains a track on which the cards are pushed by fingers extending down from the conveyor belt directly above, *Fig.* 2. The conveyor belt conveys information in coded form, and the cards are kept in the correct physical location with respect to the address number by the pusher fingers. The conveyor belt is made from two parallel chains whose links are four inches on center and are connected by a crossbar at each card position. Each crossbar carries two nylon wheels on which the chains travel and eight nylon cams that act primarily as the mechanical binary address number.

Each of the cams can be set to one of two positions, corresponding to the binary "zero" or "one", with the point either down or up. They arrive at the starting end of the conveyor in the clear or "zero" position. If it is necessary to tip the cam upward so that it becomes the equivalent of the binary "one", a pawl is moved into its path. Eight cams, each with two possible positions, provide 2^8 or 256 possible binary addresses. Since in general there are 2^n different addresses possible with n cams, it can be seen that the number of categories into which a quantity of items may be sorted is limited only by the number of cams carried by the crossbars connecting the two chains.

On the sorting operation, the cards are first dealt from the bottom of the stack and pass under a conventional 80-column card reader. When the information on the card is decoded, an electrical device decides into which pocket the card is to go and the cams are set up with the correct address number. The card is then pushed onto the track. As the cams move down the conveyor with their associated cards, they pass under a series of switches, one set at each pocket. A cam in the upward position will actuate a switch; one in the downward position will not. By properly wiring a set of eight switches, any particular 8-digit binary address number can be recognized, exciting a mechanism that will deflect the card from the track into a pocket.

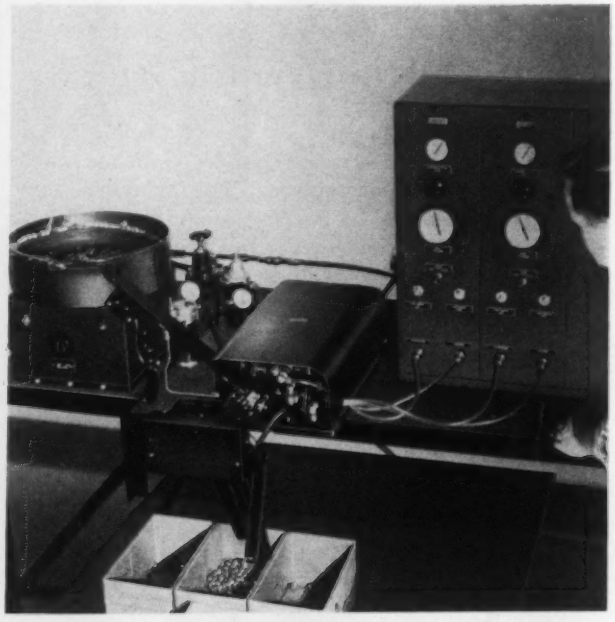
While conveyor belt sorters of this general type are not new, the NBS machine has several definite advantages. It is not a synchronous machine; that is, the card spacing in the conveyor has no relation to the spacing of the pockets. This leads to a saving in the power supply inasmuch as the cards cannot all be dropped simultaneously. However, if the pockets were to have the same spacing as the cards, on the conveyor belt, then the cards could be dropped simultaneously although this would not normally occur. Large sections of the belt may be added, as well as groups of pockets in any desired spacing, but the recognizing element in all cases must be spaced a constant distance from its associated pocket. It is also a simple matter to provide more than one pocket for one category; when one pocket fills, subsequent cards can be deposited in a second pocket. Moreover, it is relatively easy to provide a counter associated with each pocket if such is needed.

Measurement By Air Jets

INSPECTION by an automatic sorting gage represents another step toward automation in the steel fabricating field at Superior Steel Corp. Jets of air measure wall and base thickness of copper-clad bullet jacket cups in one operation. Accurate for close tolerance work, this gage will augment manual gaging previously used exclusively, and materially speed up checking and inspecting procedures.

Equipment built by Moore Products Co. of Philadelphia incorporates a number of new features, particularly the pneumatic feeding mechanism. Cups start through the gage in a vibratory feeder, "walking" up an incline and are arranged in uniform position before sliding down the gravity chute. A pneumatic cylinder timed to operate at 2500 pieces per hour brings cups into gaging position. Design of the pneumatic circuit is such that dimensions are amplified in a ratio of 2700 to 1.

A system of pneumatic relays receives the measurement signal and actuates electrical sorting gates so that unacceptable cups are sorted from those



within tolerances. Dimensions of each piece are shown on large dials in the cabinet, providing data for quality control.

Four sortings are made automatically, cups under or over tolerance in wall thickness, those over base thickness, cups under base thickness tolerance, and cups fully meeting all specifications. Design is such that any failure of electricity, air, or part of the equipment will either stop the gage or classify all work as unacceptable. There is no possibility that bullet jackets of substandard wall or base thickness will escape detection.

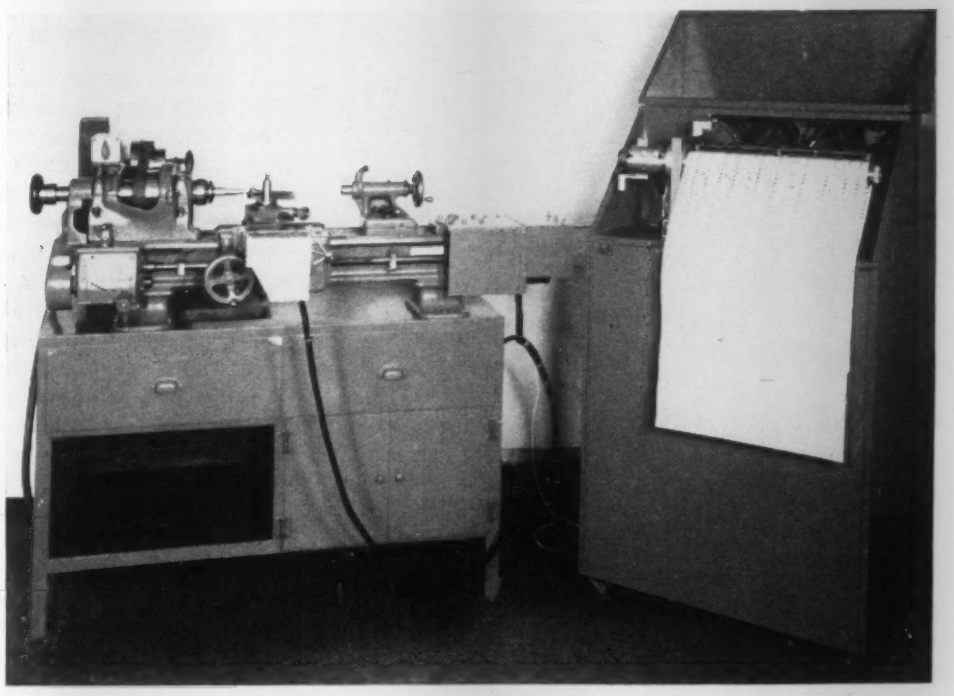


Fig. 1—Tape controlled turning lathe showing punched tape used to feed digital data to control the tool

CONTROLLING MACHINES WITH TAPE

Begun 150 years ago, tape controls have been developed to the point where real economic advantages exist for precision reproduction of complex products

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MACHINE tools have been controlled automatically and satisfactorily for a great many years — the automatic screw machine is familiar to all engineers. Another type of machine, the copying or tracer-controlled unit, has been developed more recently and is used widely in many different varieties. On these machines a first piece or templet is made by conventional methods, and then a cutting tool is guided automatically so as to duplicate the form in the sample workpiece. In some cases a master is made of wood or plaster which can then be copied in metal.

These machines all have the disadvantage of requiring that a master workpiece or, in the automatic screw machine, a set of master cams be made and installed every time the machine is to be changed from one job to another. However, if 10,000 or 50,000 or more pieces are to be made, these machines have achieved outstanding success. Should but one piece be needed, it can be hand made most easily. On the other hand, if the number to be made is 6, 10 or 25, there are no good ways of making them. A good machinist makes the second piece a little faster than the first but the third takes just as long as the second, and he can easily spoil the fifth. He has to stop his machine repeatedly to change tools and measure the work. Should the piece be complicated, it may well prove extremely expensive or impractical to duplicate within close tolerances.

Article based on paper presented at the Annual Meeting of the American Society of Mechanical Engineers, Dec. 1953.

Tape-Control of Machines

These considerations have led, during the last 150 years or so, to the development of machines

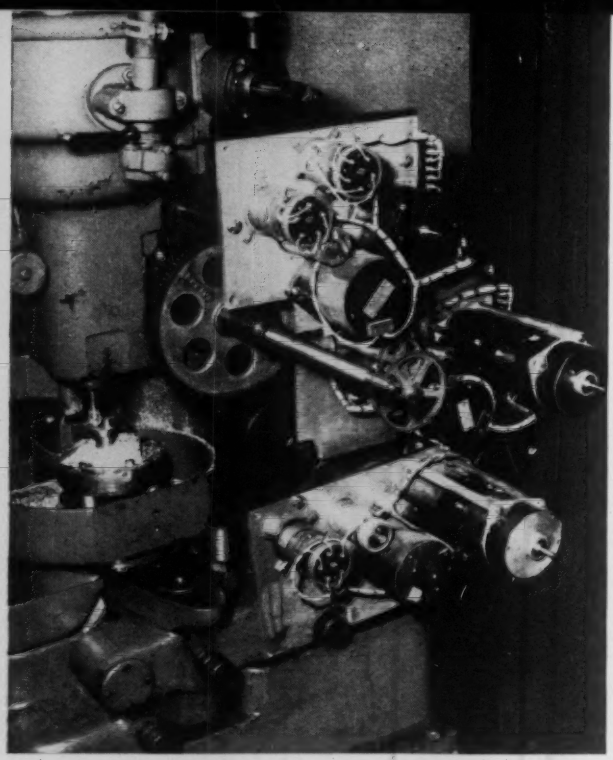


Fig. 2—Automatically controlled gear shaper showing servomechanisms employed

controlled by a tape or film, *Fig.* 1. About 1804 J. M. Jacquard invented a loom which was controlled by punched cards linked together in a chain. This control device has been applied to embroidery machines and to lace-making machines. A related system has been used widely for player pianos and organs, and a similar method for the control of typesetting machines.

With a tape system, when new orders come in for spare parts, it is necessary only to place the tape in the machine and to put in a piece of stock. In fact, the operator does not even need to know what the machine is going to make, his only requirement is the stock size and machine operation.

For exceptionally complicated pieces it is possible to prepare tapes on some of the large modern computing machines. For simple pieces however, it should be possible to prepare a tape in the user's plant. If the information can be put on teletype tape, the interesting possibility appears of telegraphing spare parts all over the world.

In the machine-tool field, the problems are somewhat different than on the earlier devices. Most of these early machines employed a hole in the tape for each particular operation or location. On the player piano the presence of a hole causes a particular note to be struck. On the loom a hole in a selected location will raise a particular thread. On a machine tool, it may be desirable to locate a point to 0.0001 or 0.0002-inch tolerance with a tool having a total travel of 50 or 60 inches. This is one part in 500,000 or 600,000. Obviously, it is impossible to have a tape 500,000 holes wide and have each put up a locating pin 0.0001-inch from the next one.

▶ Coding Systems

There are several ways to escape this problem. The first, is to use a coding system of some kind. The simplest system is merely the use of decimal dimensions. That is, if the cutter is to be 19.5732 inches from the zero point, the digits 195732 are punched in the tape. This will require that 60 spaces be available for this co-ordinate. A binary system would permit a reduction to 19 spaces, while a combination system using four spaces per decade would require 24.

The number of spaces can be reduced greatly if it is not necessary to give a single order that will drive the machine from end to end. If it is possible to use succeeding orders which do not differ from each other by more than 0.005-inch, it is necessary to put in only the last two digits. If the preceding order had been executed properly, this is sufficient. The simplest type of control system is one in which successive equal steps are transmitted to the tool. As frequently as the system will allow, a step is either fed in, or it is omitted.

Such a system requires a reliable response device. It also requires a greater length of tape than a control which uses a code to indicate the final co-ordinate of the tool. If the steps are 0.0001-inch, and the signals on the tape are ⅛-inch apart, a tape over a mile long would be required to make a single 60-inch cut. At a cutting speed of 1 inch per second the speed of the tape would be over a mile a minute. A magnetic tape will permit much closer spacing of orders than ⅛-inch, but it is a little difficult to make changes on such a tape.

▶ System Flexibility

A matter of great importance to the engineer concerned with automatic control is a knowledge of the degree of flexibility that it is desirable to put in a system. It is possible to construct a machine to do under the control of a tape almost anything that may be desired. Naturally, some things are easier to do than others. If great flexibility is required, additional complexity may result. Cost is the final controlling element. If an automatic machine will not do a job for less money than it can be done some other way, it is not practical.

The degree of flexibility required depends to some extent on the machine to which the control is applied. On a jig-boring machine, the important feature of the control is that it locate the workpiece accurately and quickly. A slight lack of uniform velocity of approach is not important nor is control of that velocity over a wide range. In a lathe, the degree of flexibility required may be important. A simple type of control can be built to do straight turning. To turn accurate tapers may add appreciably to the cost of the control system, while to be able to cut irregular forms may add even more. This will be true if the number of orders to be given the machine is to be kept low. If a large number of orders are to be given, as in a step-by-

step system, the same control will work on one as on the other, but the labor of preparing the control tape may be increased.

A machine that will do straight turning will do anything if it is done in straight steps of sufficiently small size, but this results in poor speed of operation. It may result in such poor speed that difficulties will be encountered cutting material such as stainless steel, where it is necessary to take a sufficiently heavy feed to cut below the work-hardened surface.

Cost of the control will also be influenced by the number of dimensions. While any point on a piece may be specified by three co-ordinates, the specification of a cylindrical hole requires seven in addition to the cutting speed. These can be the co-ordinates of the center of the hole at one end, the slopes in two directions, the diameter, and the length.

Each dimension requires some sort of control system. In cutting a thread the phase relationship of the longitudinal feed to the rotation of the workpiece must be maintained. It is desirable, of course, that a machine tool control should not limit the accuracy or the speed in any way. It is desirable that backlash and tool wear be taken care of and that the replacement of a tool should not influence the size of the workpiece.

If for any reason there is an error, or if some part of the machine is worn so that dimensions produced are not exactly right, it should be possible to include proper correction on the tape. When a tape is prepared it is presumed that the maximum possible cuts will be incorporated. Naturally, every once in a while the man who prepares the tape will be overly optimistic and will call for a cut which the machine is not capable of handling without damage. It should be possible, in such cases, for an operator at the machine to override the automatic control and to reduce the speed without upsetting the dimensions to which the piece will be finished.

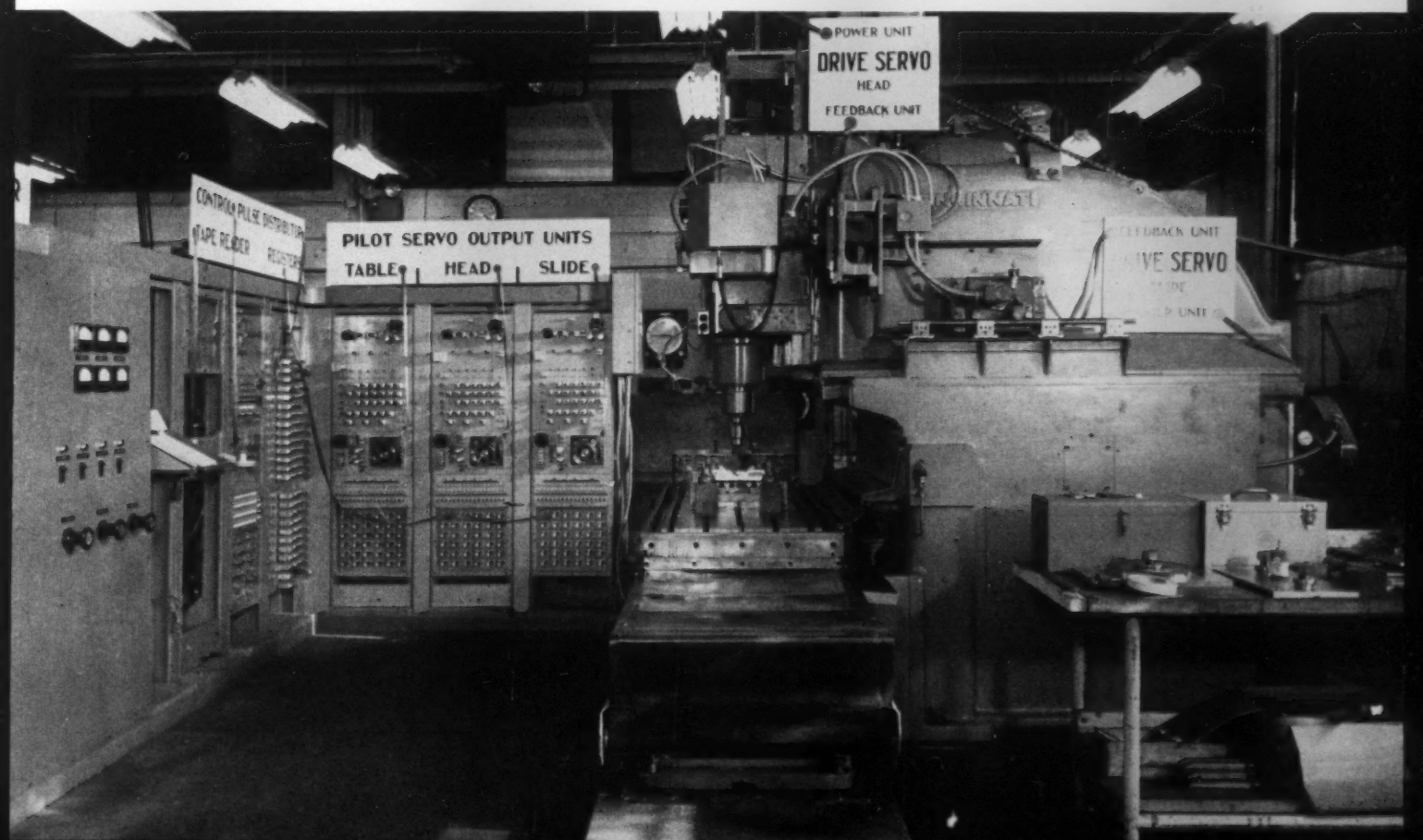
Playback Controls

One control which has received much attention in the past is the playback type. A machinist operates a machine tool in a normal manner. As he does this, the motions of the machine are recorded in some way on tape or film—magnetic tape or motion picture film, etc. When the machine is played back the motions that the machinist put the machine through, are repeated.

One of the disadvantages of this system is that if the machinist makes unnecessary motions, which he may, those motions are repeated. It is also probably true that a machinist rarely operates a machine tool at maximum possible cutting rates.

Such machines have been described in a number of patents. Some are rather old and it is difficult to determine why these devices may not have come into use. They appear practical but they have apparently not been used to any extent.

Fig. 3—Numerically controlled milling machine developed at M.I.T. with control equipment employed



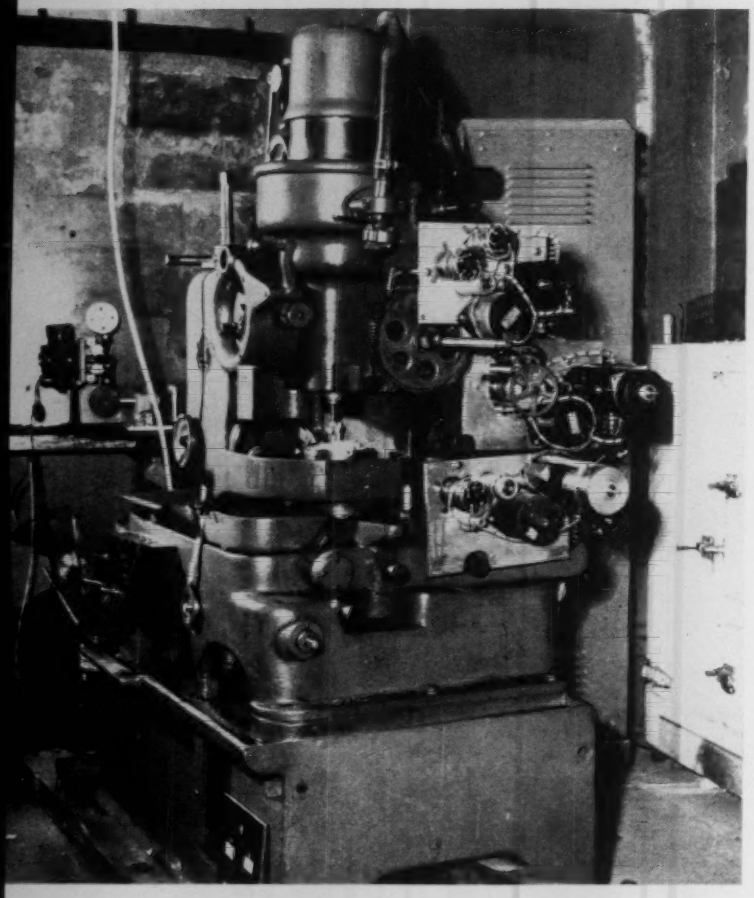


Fig. 4—View of Fellows gear shaper with tape control of cutting actions for producing noncircular gears

Safety Precautions

It is important that the equipment be reliable. Some safety precautions certainly need to be taken. To make a machine completely foolproof is probably impossible. To be completely or as nearly foolproof as possible perhaps would involve a complete double system with two tapes—a transmitting tape which would transmit information to the machine, and a checking tape which would receive information from the machine or from the workpiece. This might be from a diamond stylus riding against the work or from a point as near as possible to the work. This would transmit from the machine back to the checking tape prepared independently, in which case any discrepancy between the order and the response would result in stopping the machine, ringing an alarm, or whatever is necessary.

Naturally, the seriousness of a failure will depend on the type of machine and on the piece being made. Anything which may result in damage to the machine is serious, damage to a tool, perhaps not as important. Damage of the workpiece may or may not be important, depending on its value.

It is important that the machine control be easily serviced. That, naturally, is of less importance as the reliability of the machine goes up. A machine which is likely to break down requires easy servicing; a machine which is unlikely to fail, can tolerate some difficulty.

Electronic Control Equipment

An important reason that automatic controls were not applied to machine tools many years ago was the lack of sufficient experience with servomechanisms, vacuum tubes, and the like. During the last 20 years a great deal of progress has been made in the servomechanism field for military purposes and practical applications are numerous, *Fig.* 2. Vacuum-tube servos and thyratron servos are both reliable. Most failures in these systems have been mechanical. Loose connections, which are of a purely mechanical nature, are as likely a cause of trouble as anything else. Vacuum tubes do fail, sometimes gradually, sometimes all at once. Of course, sudden failure is usually mechanical.

Work is being done today with transistors, which it is hoped will be better than tubes. The principal advantage so far is that running temperature is lower because there are no cathodes to heat. This results in considerable advantage with amplifiers operating at low power levels.

Magnetic amplifiers will certainly be used in the future for the somewhat higher power levels, the driving servos. There are also friction drives such as the mechanical torque amplifiers using metal bands wrapped around drums. For low powers, a straight synchro—similar to a wound-rotor induction motor—transmission has been used.

Power requirements for machine tool control may turn out to be surprisingly large. Lathes, for example, may require, under the worst conditions, three or four per cent of the power required to drive the spindle. A lathe developing 25 hp at the tools may require as much as one horse-power to drive the tool carriage. This takes such servos out of the instrument class, which ordinarily have maximum output of a few watts, and raises them into the power-drive class, perhaps as much power as it takes to drive a 3-inch gun.

Tape-Controlled Machines Constructed

Several tape-controlled machine tools have been constructed or described within the last few years. One simple system, developed by Dr. Herman Cousins, makes no attempt to operate the machine at its maximum capacity. Its function primarily is to produce parts so intricate as to be extremely difficult to machine by ordinary methods. The equipment uses a tape about 4½-inches wide and handles four co-ordinates with 16 possible values for each of the co-ordinates. There are four tracks in the tape for each co-ordinate. Combinations of the four give 16 possibilities. For every step four holes are punched. They may be in one of two

different rows, and there will always be a hole in one row or the other.

A small rocker mechanism brought toward the tape, rocks one way or the other, depending which hole is punched. As it moves further, it encounters a dog which forces the rocker on in the direction in which it is moving. Then, it closes electrical circuits which operate relays to provide any one of 16 different sets of voltages which are fed directly to a synchro motor. This motor simply drives the proper carriage of the machine tool. The steps are each 22½ degrees of synchro rotation, corresponding to a motion of 0.001-inch.

Synchro motors employing such angles of drive are capable of delivering considerable torque and power. If the steps used are much smaller it would be necessary to use servomechanisms to aid the synchro in driving the load. There is no provision, at present, for backlash compensation. If the amount of backlash is known, it can be allowed for, or if turning is done from the outside, it is always in the same direction. If the tool wears, some adjustment must be made.

If for any reason the machine fails to respond to one step, the next step will correct by moving the synchro 45 degrees. For that matter, double or triple steps can be used, if desired, to increase the speed of operation. As long as eight or more are not present at one time, the headline will drive in the right direction. In practice, it is probably not advisable to put in more than three. Considering speeds and accelerations, it might happen that lags in the system would be such that two steps of five put in from a standstill, would produce a resultant rotation in the wrong direction.

Another system, considerably more elaborate, is a numerically controlled milling machine built by Massachusetts Institute of Technology. In this machine, *Fig.* 3, the operation in each co-ordinate is essentially in a straight line, although it is actually divided up into little steps each way. However, it is necessary only to put in in coded form the length of travel which a cut is to have, and the time to be used to complete the cut. The minimum time that can be used is two seconds. The machine operates by taking steps at a fixed rate of 512 per second and then taking as many of those steps as are necessary. If the machine is to travel at full speed, in a second it will take all but one of them. If it is to travel at half that speed, it will take every odd step or at a quarter of that speed, it will take the second, sixth, tenth, and so on. Intermediate speeds are taken by adding groups of steps. At ¾-speed, the steps used for half-speed are taken with those for ¼-speed. There is a rather ingenious system for doing this, based on

Fig. 5—Group of noncircular gears produced by film control of gear shaper, require no special tooling or setup

the properties of binary counting systems and the use of a pulse which does not carry to the next one.

Steps on the MIT milling machine have been 0.0005-inch which gives a maximum cutting speed of 15 inches per minute. This is a respectable speed, but it is nowhere near the highest useful speed of the milling machine employed. It is understood that in cutting aluminum it is not unusual to operate these machines at the rapid traverse speed of 120 inches per minute. On a lathe it is felt that somthing around 60 inches per minute for the longitudinal speed, and perhaps a little less for the cross feed, would be suitable maximum speed rates.

A few years ago Arma Corp. built a lathe on which the information introduced was in the form of co-ordinates of the point at which the tool was to end its motion and the speed with which it was to travel in each direction, *Fig.* 1. Each of these was fed in digitally in the form of a voltage from a decade voltage divider, consisting of taps on a toroidally wound transformer. It has been found that the voltage from these taps is proportional to the number of turns within one part in 100,000 or better. Even this is not a limitation. By a little manipulation of high and low-speed systems, it is possible to operate to even much closer tolerances.

When the machine was built speeds were not in as close steps as they could have been. At the time, it was contemplated that the machine would handle straight turning and rough tapers. Actually, it is possible with this system to cut tapers with a tolerance of perhaps a tenth of a degree for whatever length is desired. If it is necessary to have closer tapers than this, they can be cut in steps. That is, a short section can be cut and machine repositioned. This would leave a visible ring on the work at each such point, but it still would be everywhere within a reasonable tolerance. This machine, as built, was capable of driving the carriage about 60 inches per minute at no load. Maximum power was delivered at about half this speed. Reproducibility or accuracy was very good. Successive pieces did not vary more than 0.0002-inch in diameter, which is closer than most lathe operators can set the cross slide on a manually operated lathe.

Another automatically controlled machine tool is a Fellows gear shaper to which servos have been added to simplify cutting of noncircular gears, *Fig.* 4. Control is with 16 mm film. The principle of operation is that any noncircular gear can be generated by a rolling of the pitch line of a circular gear along the desired pitch line of the noncircular gear. On the gear shaper, the motions available are rotation of the work spindle, rotation of the cutter spindle, and motion of the cutter spindle toward the work spindle. In normal operation of the gear shaper, the two spindles merely are geared together in the proper ratio; the cutter spindle is driven toward the work spindle during a portion of the rotation while the cutter is fed into the work, and then both proceed to rotate at constant center distance. In the noncircular case, it is necessary to rotate the work spindle and the cutter spindle at relatively varying rates and, at the same time, to drive the cutter spindle toward or away from the work spindle.

The method of doing this is to divide the required motion of each of these into steps. The steps of work rotation are two minutes of angle, the steps of cutter rotation are equivalent to 0.01 of a tooth, which is 0.015-degree on a 24-tooth cutter. Steps of motion of the cutter spindle toward the work spindle are 0.00025-inch. Computation is complex but involves making steps of any one of the three or any combination of the three motions.

Principal features of the system are the use of standard components. There is little special work, as the 16 mm film is run through a home movie projector from which the intermittent motion has been removed. As each spot passes over a phototube a relay is operated along with a stepping switch—which is not used as a switch—geared to a synchro. The three synchros transmit to receiving synchros which control servomechanisms on the gear shaper. The operation is not fast.

The idea behind this machine was quite different from that of the lathe. In the case of the lathe, the object was to make a machine which could be converted quickly from one job to another. It was intended to take only seconds to change a piece of stock and the tape, and only a few minutes to prepare the tape. It was hoped that in making as few as two pieces this machine would be of value. In the case of the gear shaper the object was a machine which would make a piece difficult to produce by any other known means, *Fig.* 5. The amount of work required for set up was of secondary importance. Actually, there was 100 or more hours of calculation and work in preparing the film.

Just the Ticket

DESIGNED primarily for merchandise control in the retail industry, an IBM ticket converter automatically transposes data from small price tickets or stubs onto punched cards for use in mechanized preparation of reports. The machine can summary punch and gang punch cards in addition to the basic "ticket to card" function, extending its use into areas of inventory, production control, piece work payroll, and similar accounting applications in other fields.

Cards are automatically checked for accuracy during the process, then are ready to be run through standard machines to produce required reports. Small tickets can be made up in from one to six parts, so that any one part may be detached and used for billing branch stores, inventory control, sales transfers, or returns.

SHEFFIELD

AUTOMATION Gages

Assure Fast Accurate Machining

Sheffield Automation Gages are package units, ready-to-use and economically priced, for the control of grinding, boring, drilling, honing, milling and turning operations.

Mounted on machine tools, they measure work part dimensions and space relationships and instantly translate this information into electrical impulses which in turn:

- **Energize signal lights**
- **Actuate solenoid ejection or classification mechanisms**
- **Start and stop the machine tool**
- **Provide feed-back control**
- **Control cutting tool or grinding wheel positioning and compensation, also time cycle.**

A Typical Application

Here the bore of transmission pinions is being honed and gaged automatically.

If the actual bore size, after honing, is within .0001" of either tolerance limit, white warning lights flash on.

If either tolerance is exceeded, a red or green signal flashes and the faulty part is automatically ejected.

When a predetermined number of rejects pass through in succession the machine is automatically stopped.

The actual size of each bore, as it is gaged can be read on a conveniently located air gage dial as built into the machine tool pneumatic circuit.

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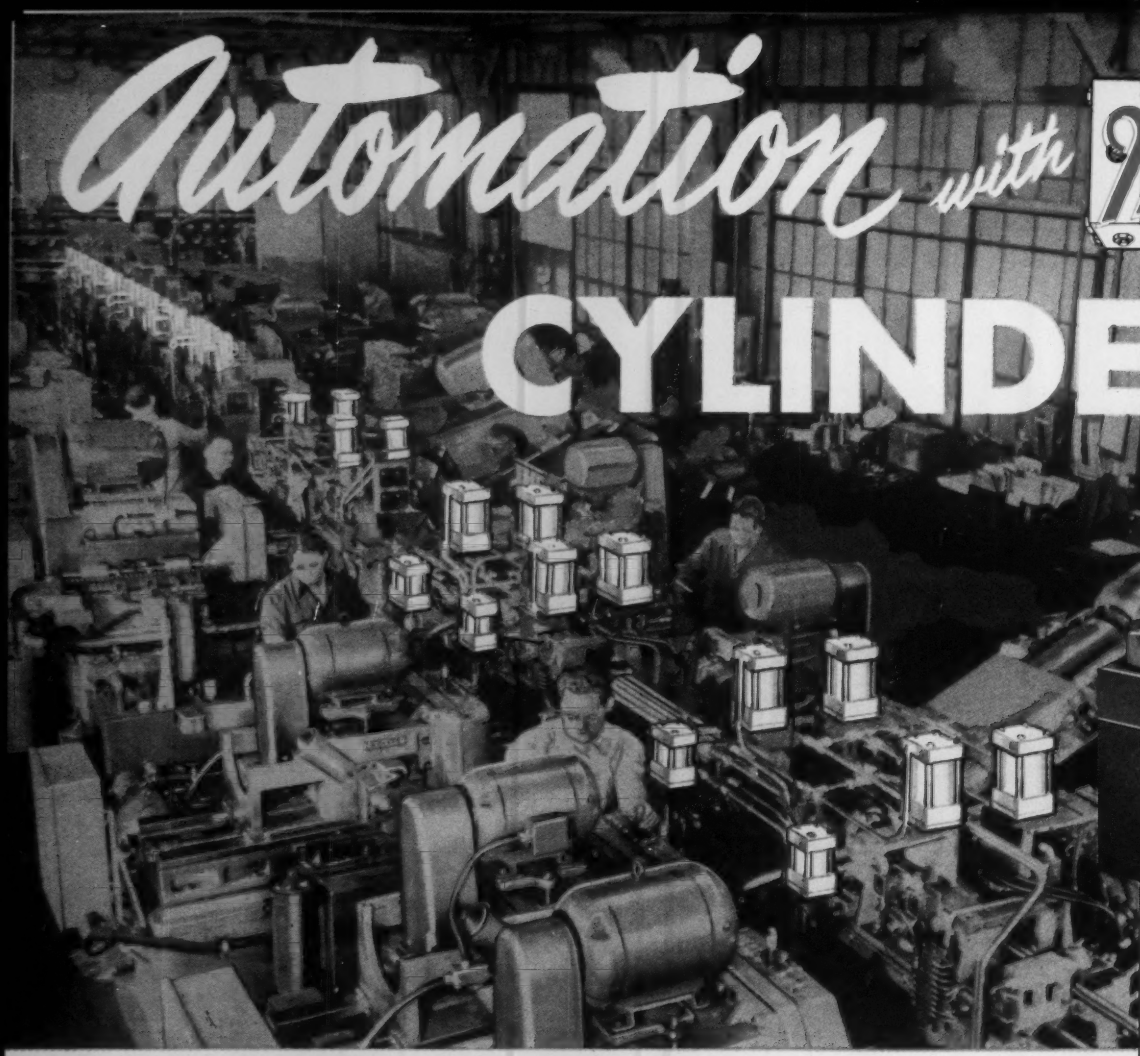
6891

Automation with Miller CYLINDERS



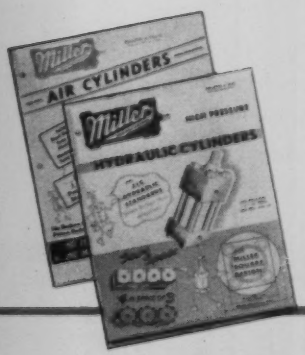
...assures non-stop production flow with BIG savings in maintenance and investment cost!

The production magic of "AUTOMATION" demands faultless performance—as the failure of one important component of "automation" machinery and equipment can shut down an entire manufacturing process.

In the "automation" application illustrated above, 22 Standard Miller High Pressure Hydraulic Cylinders are employed on each of two identical automotive transfer machines built by Ex-Cell-O Corp. of Detroit, Michigan, a recognized leader in the design and manufacture of "automation" equipment.

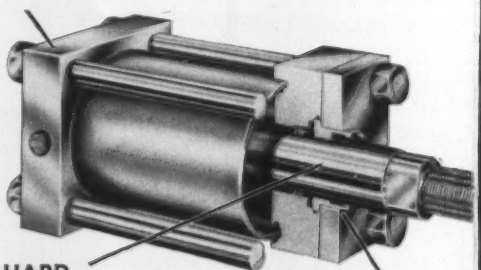
The machines perform—simultaneously and automatically—drilling, countersinking, counterboring, and tapping operations on automotive cylinder heads. And the Miller Cylinders accomplish the vital clamping, feeding, holding, rotating and locating operations that enable the machines to function as smooth "automation" production units.

Miller Cylinders are ideal for such "automation" applications. They withstand severest shock loads, provide millions of smooth strokes without repacking of seals or other maintenance. Their space-saving square design cuts installation and designing costs. They're available in an infinite variety of versatile power and stroke units that cover every need and permit the most economical choice for the application. And they fully meet the J.I.C. Standards.



Consult our engineering department or local representative. And write for complete information on this and other interesting applications and for our FREE Cylinder Bulletins A-105 and H-104.

SOLID STEEL HEADS, CAPS and MOUNTINGS Eliminate Breakage



HARD CHROME PLATED PISTON RODS Prevent Scratch-Damage, Nicks and Rust

DIRT WIPER SEALS Protect Rods, Seals, Bushings

MILLER FLUID POWER CO.
(Formerly MILLER MOTOR COMPANY)

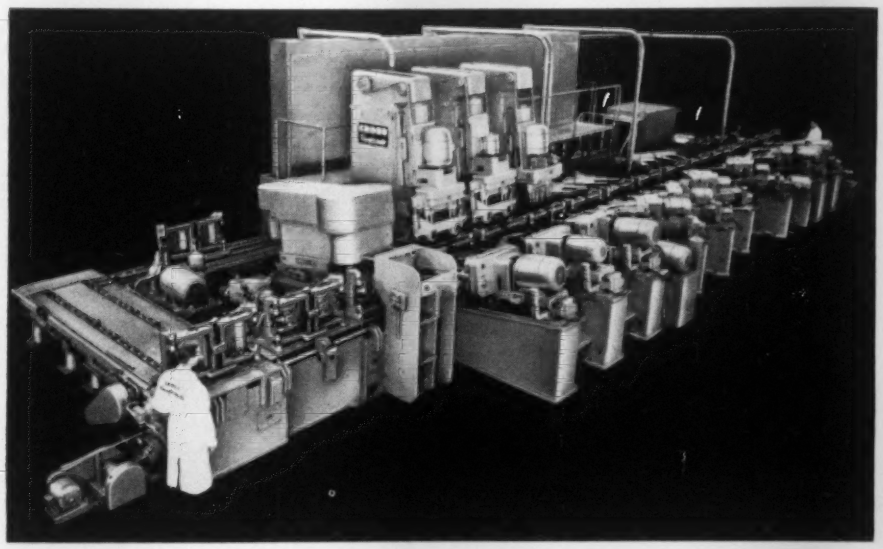
2015 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

AUTOMATION NEW EQUIPMENT



MACHINING INTAKE MANIFOLDS

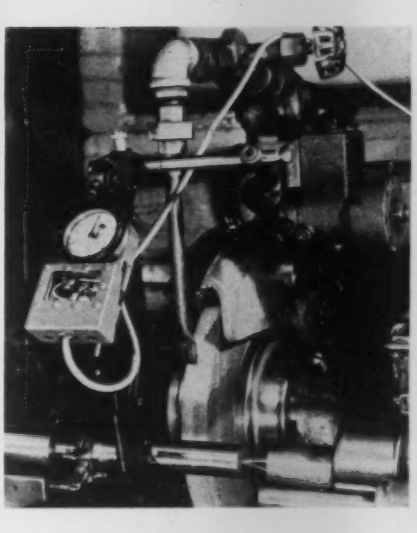
Intake manifolds can be machined at a rate of 206 per hour by automatic multi-station machine which performs 100 operations per manifold. In the twelve working stations, workpieces are milled twice, drilled 48 times, bored 4 times, chamfered 20 times, spotfaced 4 times and tapped 22 times. Two additional stations load and unload material. Palletized work holding fixtures with power wrenches clamp automatically. Integral conveyor automatically returns palletized fixtures from unloading to loading station. Unit features automatic chip removal, hardened and ground ways, and an automatic lubrication system. **Cross Co.,** 3250 Bellevue, Detroit 7, Mich.

Circle No. **1** *on Reply Card*

WELDS PRECIOUS METAL

Two automatic welding machines have been designed for disk and point type welding of precious and semiprecious metal contacts to leaf springs, small contact arms and other instrument components. Gold, silver, platinum, palladium and iridium can be used for the weld. Shape of point contacts may vary from small pin point to a dome shape, 0.070-in. base diameter and 0.060-in. high. Location accuracy of contacts can be held to 0.001-in. Diameters of disks can vary from 0.025 to 0.187-in. in fine silver, and to 0.125-in. in other materials. Production rate is 1200 to 2400 contacts per hour depending on operator's rapidity in loading parts. Thyratron unit controls welding current so that operator can select at will a current of from 1 to 10 cycles. Uniform current is assured and each weld is as similar as possible. **Sheffield Corp.,** Dayton 1, Ohio.

Circle No. **2** *on Reply Card*



GRINDING GAGE

A new electric grinding gage can be used to control a grinder automatically, insuring proper size on every piece ground and eliminating scrap and rework. Model 133M gage is basically an Arnold grinding gage frame and caliper with a Federal Electricator instead of the regular dial indicator, plus a power unit. The Electricator combines a dial indicator with an electric switch which is connected directly to the power unit.

Continual operation is possible

because the operator need not stop grinding to gage the work for size. Automatic control of the grinder begins as soon as the gage is snapped on the work. The gage can be snapped on at any time before the work cycle starts, while the wheel is coming forward, or while the work is being ground. The gage rides the work during the grinding and controls the wheelhead feeding mechanism. Wheelhead runs at a rapid grinding rate until the work diameter reaches between 0.005 and 0.004-in. of final size. The choice of changeover point depends on grinding speed. At this changeover point, the wheel is switched by the gage control to a slow spark-out feed. When final size is reached the wheel is retracted. The retraction point is determined by the size of the workpiece rather than by the use of a timed cycle. Accuracies of 0.00005-in. over a prolonged period of time are reported.

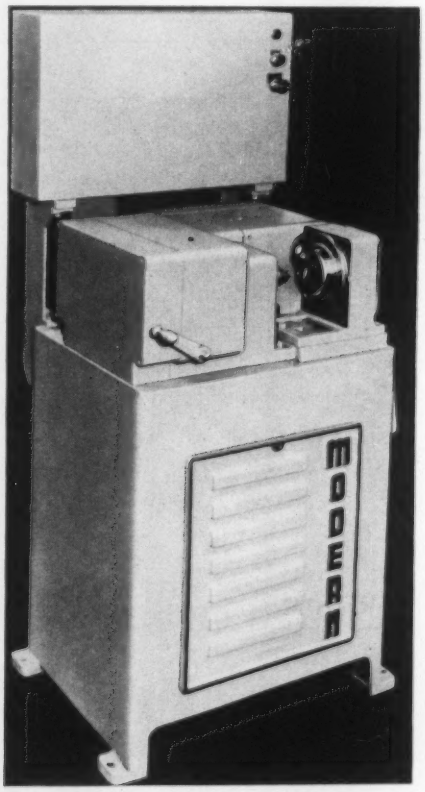
A splashproof case encloses both the indicator movement and the electric switching unit to protect them from splashing coolants. The case has a window to make switching contacts visible when setting tolerance limits. Adjustment screws are enclosed by a shield for protection from accidental turning after tolerances have been set. A separate power unit eliminates the necessity of manually resetting the gage after each work cycle. Should there be a power interruption or relay contact failure in the gage circuit, the grinding wheel retracts automatically. Power unit can be installed in the control panel of the grinder or in its own enclosure at any convenient place. **Federal Products Corp.,** 1144 Eddy St., Providence 1, R. I.

Circle No. **3** *on Reply Card*

PRODUCTION LINE GENERATOR

Convenient worktable, 33 x 100-in., is incorporated into design of high frequency generator as top of generator cabinet for use in production line operations. Control panel, with manual or automatic controls and with provision for remote control, is placed within easy reach of operator, and panel lights give continuous indication of all operations. Generator will induce extremely high temperature within a few seconds in any conductive material, metallic or otherwise. Rated output is 10 or 20 kw, continuous duty. Frequently applied to heat treating, stress relieving, hardening or brazing, induction technique also can be used in problems such as heating electronic tube elements while vacuum pumping where no physical connection is made between equipment and workpiece. Table is backed by insulation to prevent reverberation and heat transfer, and has formed edges to permit use as a tray for quenching solutions. **Electric Arc, Inc.,** 152 Jelliff Ave., Newark, N. J.

Circle No. **4** *on Reply Card*

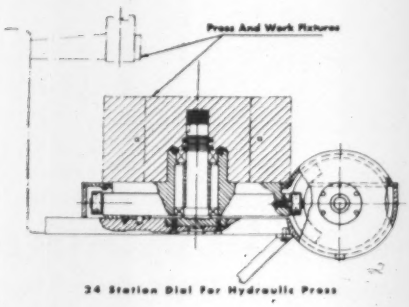


BURRING, CHAMFERING

Burr-Master will deburr and chamfer internal splines, straight sided or involute form helical or spur gears ranging from $\frac{5}{8}$ to $3\frac{1}{3}$-in. pitch diam. Splines or gears can have from 9 to 42 teeth depending on the tooth pitch. Patented action will chamfer both sides of tooth and root simultaneously at the rate of five teeth per second. Depth of cutting stroke is infinitely variable and production can be shifted from one gear to another with minimum time loss. Only tooling changes necessary are the spline driver, workholding fixture, tool holder, form tool and change gears. Three or four cutting edge, circular type form tool is long lived because of rotation of edges as each edge dulls. No adjustment or tryout is necessary because tool is positioned positively against a

stop. Control indicator lights when a part is finished to signal operator to reverse control lever and stop the machine with tools automatically in retracted position. Machine is equipped with conventional camming to handle most internal deburring and chamfering jobs. However, special interchangeable camming can be furnished for unusual forms of splines or gears. Motor is 220/440 v, ½ hp, 3-phase. Weight is approximately 800 lb and floor area requirements are 26 x 26½-in. **Modern Industrial Engineering Co.,** 14230 Birwood Ave., Detroit 38, Mich.

Circle No. **5** *on Reply Card*

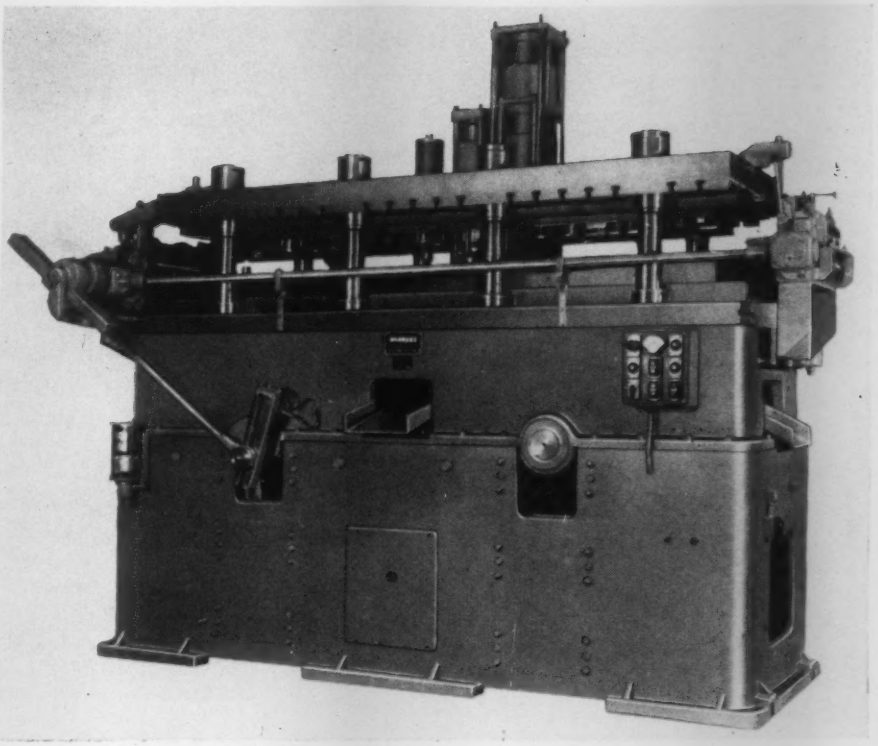


24 Station Dial For Hydraulic Press

PRODUCTION INDEXING

High speed, precision indexing tables are available in custom housing for incorporation into new or existing machinery. Indexing is designed for high speed with punch presses, die machines, hydraulic presses, bottle crown machines, and multi-color printing presses (illustrated dial has 24 stations and operates with a hydraulic press). Versatile basic design permits indexing at any position of cycle, and permits any number of stops, the standard roller gear drive being built for four or more stops per revolution. Inherent locking and zero backlash eliminate need for auxiliary locating devices and give extreme precision in location. Life expectancy of table with precision work is 8,000 hours, with non-precision work 20,000 hours. Subject only to rolling friction with no play and made of hardened and ground tool steel, concave barrel cam has indeterminate life. Replacement of standard ball bearing followers in the roller gear drive renews drive. **Ferguson Machine & Tool Co.,** Box 191, St. Louis 21, Mo.

Circle No. **6** *on Reply Card*



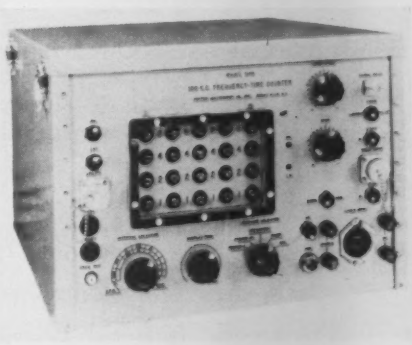
MULTIPLE-CRANK DIE PRESS

Trend to automation in all industries was sensed in design of a series of multiple-crank progressive die presses which are now available on the market. These presses are unique in that they are first to utilize more than a single crank to do one stamping job on progressive dies, thus eliminating repeated handling on conventional presses. The cranks are evenly synchronized and presses are designed to add any number of double-crank combination installations.

These double-crank units are engineered in sizes from 100 tons to 4000 tons. Very high capacities are made possible by the size of the cranks and balanced design. The smaller 100-ton press will take a progressive die up to 100-in. in length, or a little over 8 ft. The giant 4000-ton press takes a 20-ft die. Strokes are available up to 24 in. to permit an unusually deep draw. Ample space for die cushions on top platen and inside the press also facilitates deep-draw work. Die is under even pressure in all stations. The top platen is always parallel with the bed—there is no tipping under load. Stampings can be held to close tolerances and dies, are longer lived. Low center of gravity eliminates vibration while compact assembly reduces machine height. All parts are easily removable to prevent complicated teardowns.

Multiple-crank presses are currently being used by the automotive industry to produce hub caps and inner headlight bowls. Industry says that one press alone produces more than nine conventional presses and at less cost. **Brandes Press Co.,** 6408 Euclid Ave., Cleveland 3, O.

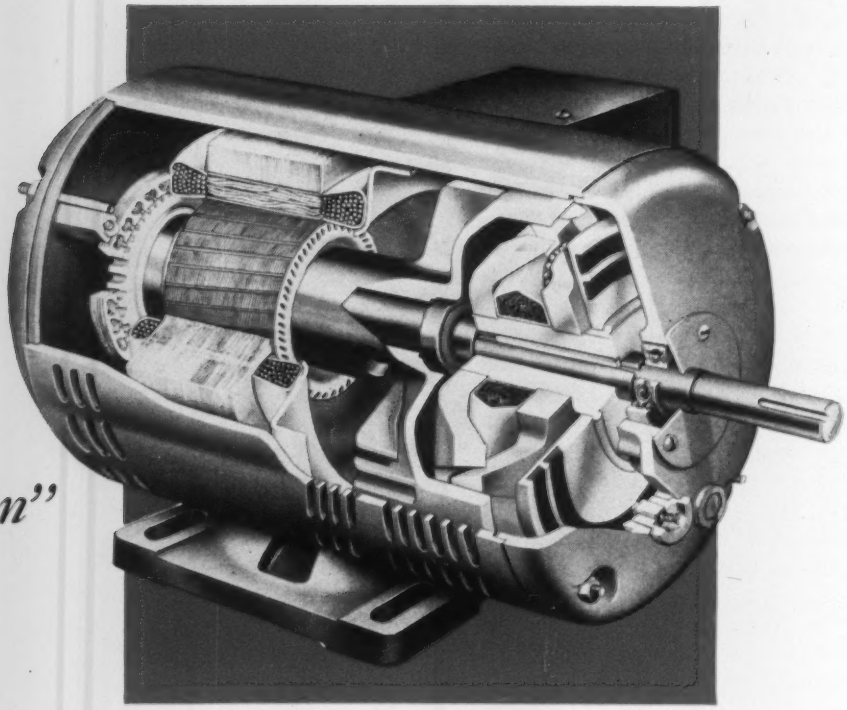
Circle No. **7** *on Reply Card*



150-KC TIME COUNTER

A general purpose instrument for direct frequency and time measurements under field conditions will measure up to 150-kc. High frequencies are measured by

For the
"Age of Automation"



Dynamatic Fractional HP Ajusto-Spede Motors

Give You Infinitely Adjustable Variable Speed Drive from an AC Power Source

These famous Ajusto-Spedes—now available in sizes ranging from 1/4 HP to 75 HP—provide the solution to many automation drive problems at surprisingly low cost.

Fractional HP Ajusto-Spedes are compact, self-contained units, an integral combination of AC constant speed induction motor, eddy current coupling, and electronic control.

All fractional horsepower Ajusto-Spedes are rated 115/220 volts, single phase or 220/440 volts, 3 phase. Sizes are 1/4, 1/3, and 1/2 horsepower at 1600 RPM; 1/2 and 3/4 horsepower at 3200 RPM.

If you have fractional horsepower adjustable speed drive problems, write for a copy of the Dynamatic Bulletin FAS-2. Bulletin GB1, which describes other Dynamatic Eddy Current products, is also available.

Ajusto-Spede® Advantages:

- ★ Constant torque speed range: 10 to 1 with 1600 RPM Ajusto-Spedes; 20 to 1 with 3200 RPM units.
- ★ Control accuracy: 2 per cent of top speed at any point within the speed range.
- ★ Minimum wiring to power line.
- ★ Remote "one knob" control operation up to 100 feet.
- ★ Rugged plug-in type integral one-tube electronic control.
- ★ Permanently sealed grease-packed bearings.
- ★ Power output shaft extension at both ends of drive.

DYNAMATIC®

DIVISION EATON MANUFACTURING COMPANY

KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio

five electronic counter decades which count unknown's cycles for an exact crystal controlled time interval. Low frequencies are measured by counting time-base pulses during 1 or 10 cycles of the unknown. Time intervals are measured to 0.00001 second accuracy. Instrument can also serve as a secondary frequency standard and as a totalizing counter.

Ruggedness is stressed in construction and in all components. Reinforced, drip-proof cabinet is of extra heavy gage aluminum, and all switch contacts are gold plated. All components are turret lug mounted, and subassemblies are mounted on plugs that can be anchored. Capacitors are plug-in electrolytic types. Time-base signals and frequency measuring intervals are provided by a crystal controlled, 100-kc oscillator and five phantastron frequency dividers. Counter is available with 4-lamp, binary-coded decimal or 10-lamp indication. Optional accessories include a mechanical register to extend count indication to 11 digits, and high speed printers and recorders to make permanent records automatically. **Potter Instrument Co., Inc.,** 115 Cutter Mill Rd., Great Neck, N. Y.

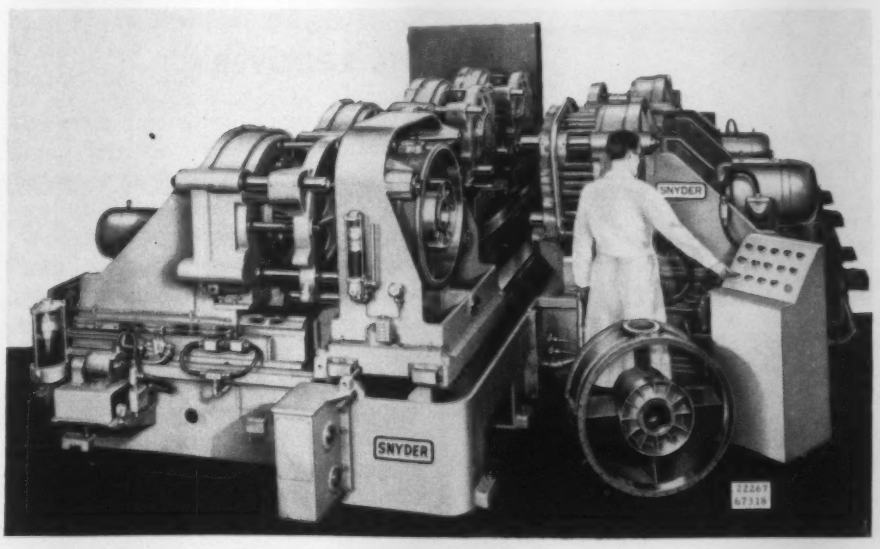
Circle No. **8** *on Reply Card*

DRUM PROCESSING

An automatic cycle, four-station, line-index machine for processing large shaped drums of cast aluminum alloy is so efficient that it may be operated by unskilled help. The machine processes the workpiece by drilling 140 holes and reaming and chamfering as required. The workpiece is an aircraft part, 32 in. in diameter and 12 in. deep, consisting of an outer drum and a central boss joined by four ribs.

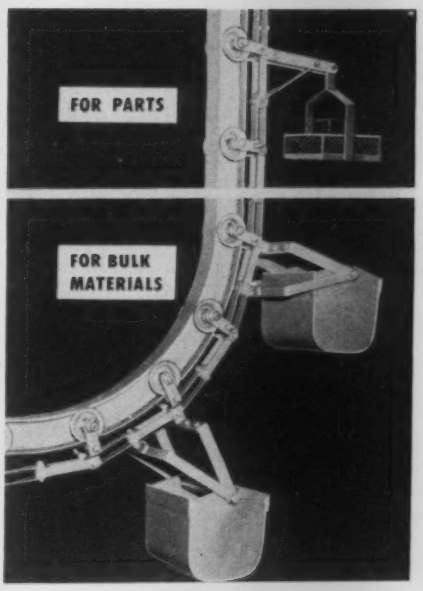
A chain index mechanism, driven by a fluid motor, moves the work through the stations. High-speed tools are used at 250 surface feet per minute with various feed speeds. Spindle drive motors use 80 hp and hydraulic drives use 10 hp. Motorized automatic lubricating system is built in. Necessary floor space is 232 x 289 in. The machine will process six pieces an hour at 80 per cent efficiency. **Snyder Tool & Engineering Co.,** 3400 E. Lafayette, Detroit 7, Mich.

Circle No. **9** *on Reply Card*



BUCKET CONVEYOR

Buckets which are self-loading and unloading because of a "Stif-Arm" hanger design, and a single I-beam which can carry loaded buckets horizontally, rise or descend vertically or at any inclined angle, and turn left or right horizontally, constitute a conveying system ideally designed for bulk materials handling. "Stif-Arm" bracket brace holds bucket trunnions a fixed distance from trolley chain and beam, and prevents buckets from swinging loosely and spilling their contents on vertical or inverted runs. Buckets remain upright at all times by rotating



around their trunnions until they reach tipping rollers for discharge station. Because of upright bucket hanger design, multiple-plane path is possible with a single conveyor and numerous transfer points are eliminated. Single drive unit, sprocket or caterpillar type, operates conveyor. Capacity is as high as 10 cfm and chain travels at 60 fpm. Buckets' capacity is ¼, ½ or ¾-cu ft. Tipping rollers for emptying buckets may be in fixed position or may be electrically or manually controlled for unloading at several different discharge points. Conveyor may be installed in inverted position, buckets on top, for carrousel applications. Wire baskets or pallets may be substituted for buckets to convey parts. Bulk materials conveyor will handle include coal, ashes, chemicals, catalysts, food grains, salt, sugar, foundry sand, abrasive fines and mixes. **Hapman Conveyors, Inc.,** Kalamazoo, Mich.

Circe No. **10** *on Reply Card*

PRESET COUNTER

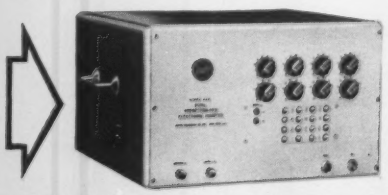
High speed counting provides industrial control in production processes that involve continuous unit flow, or in any movement that can be measured by an electrical or mechanical device. An electronic preset counter provides an electric circuit closure at the instant a predetermined value of count is reached. This closure can be used to start, stop, divert,

we like people...
but...

...we know that "to err is human". In this dynamic day of automation, there is no room for error. Potter instruments provide low-cost, high-speed, exact process control without the human "error factor". And everybody benefits.

There is a Potter instrument for controlling your industrial process. Our engineers will show you how to apply counting techniques to automatize any multiple-sequence machine operation involving control of such phenomena as weight, length, time, quantity, and rpm.

THE DUAL PREDETERMINED ELECTRONIC COUNTER (Model 244) illustrated here recycles automatically and instantaneously. Rugged electrical and mechanical design assure unattended operation over long periods of time with minimum maintenance.



Write today for further information. See how you can save time and money and improve production at the same time.

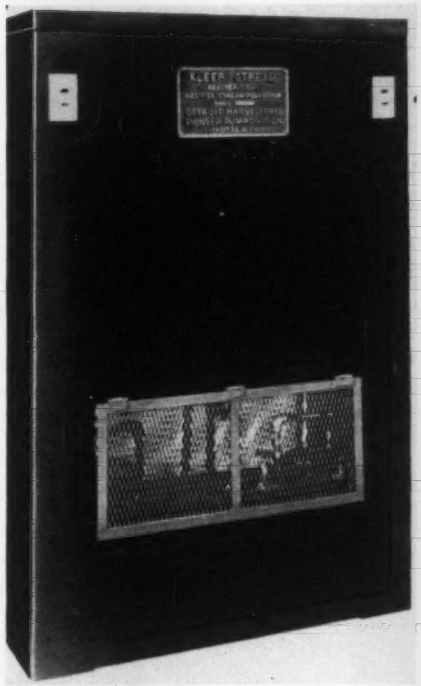
POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N.Y.

modify or measure a continuous process flow, operate an alarm, record a batch, bring in an auxiliary process function, provide any conclusive action as a result of complete count. Automatic or independently controlled recycling occurs at the instant the predetermined count is reached. Electromechanical register can record one million predetermined counting cycles. For instance, in a food processing plant the counter would record one million cases, each containing its designated number of pieces. Instrument counts strokes, electrical signals or similar impulses which recur regularly or irregularly between zero and 5000 counts per second. Used as a straight counter, the instrument records up to 10 billion units. It will respond to input impulses of either polarity and any voltage between 4 and 60 v derived from a trip wire, pressure or cam switch, relay contact, photocell, magnetic or crystal pickup, strain gage or similar transducer. **Atomic Instrument Co.**, 84 Massachusetts Ave., Cambridge 39, Mass.

Circle No. **11** *on Reply Card*

OIL RECOVERY

Oil recovery units can now automatically salvage oil and compounds normally lost as sewage, and can reduce substantially expenditure for coolants and compounds. Recovery unit is used with parts washers, coolant sumps and reservoirs handling liquids containing oil. Oil is quickly separated from washing solution and re-usable solution is returned to washers automatically while oil is stored in reservoir in top of unit. Controlled by float and solenoid valve, unit requires no auxiliary



pump when used with machines or reservoirs containing immiscible liquids which may be discharged into unit by gravity flow. Otherwise, pipe or hose connection is necessary.

Liquid goes to center compartment and is discharged into a baffle or trough which is suspended around an axis. This axis makes it possible to control the turbulence of the liquid as required to provide maximum efficiency for specific application. Only manual part of operation is drawing off the oil when storage tank is full. Unit can be used for separation of other types of liquids which will remain in suspension when mixed. Over-all size is 40½ x 61¼ x 12¾-in. **Pioneer Pump Division, Detroit Harvester Co.,** 2750 Guardian Bldg., Detroit 26, Mich.

Circle No. **12** *on Reply Card*

CONVEYOR TURNTABLE

Rotating carrier disc, 48-in. diam, floats packages around intersections of 90° or 180° between parallel or right-angle conveyor lines where gravity or power conveyor curves cannot operate. Turntable is supported by four rubber wheels and friction-driven by a rubber faced wheel contacting inner side of steel reinforcing ring welded to underside of disc. One-half hp mo-

A.C. or D.C. Feedback with DIEHL

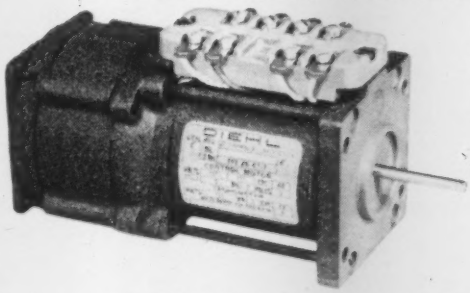
LOW INERTIA SERVOMOTORS AND INTEGRALLY-MOUNTED TACHOMETERS

Response and stabilization of *Positioning Systems* can be improved with the Diehl Servomotor and *A.C. Tachometer*. *Analog System* integration is facilitated by the use of the Diehl Servomotor with *D.C. Tachometer* combination.

Save space . . . and eliminate coupling problems and backlash . . . with these integrally combined units, motor and generator on the same shaft.

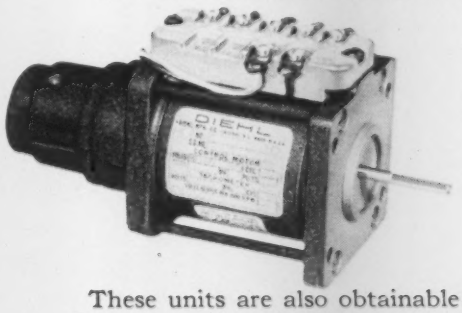
Diehl 5-watt output, 2-phase, 115/115 volt, 60 cycle, 2-pole Low Inertia Servomotors are available with a drag-cup type A.C. generator or with a permanent magnet D.C. generator mounted on the Servomotor as an integral unit, as illustrated:

MOTOR WITH A.C. TACHOMETER—NO. S.S. FPE25-67-1



Stalled torque: 5.0 oz. in.
Rotor moment of inertia: 0.18 oz. in.²
Tachometer output: 6 volts/1000 R.P.M.

MOTOR WITH D.C. TACHOMETER—NO. S.S. FPE25-86-1



Stalled torque: 5.0 oz. in.
Rotor moment of inertia: 0.18 oz. in.²
Tachometer output: 6.5 volts/1000 R.P.M.

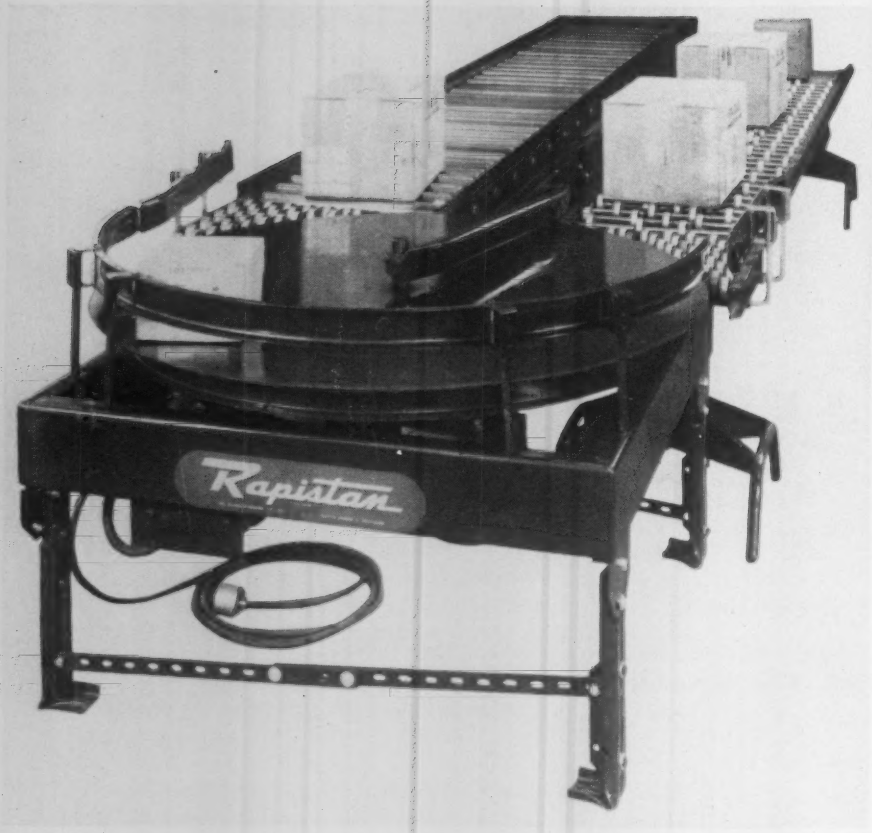
These units are also obtainable for 10 watts output. Both the 5 and 10 watt units can be supplied with control windings for operation directly from the plates of vacuum tubes, or for 400 cycle operation.

Our engineering staff will gladly help you select the units best suited to your specific requirements. A request on your letterhead will bring you a copy of Technical Manual No. A-0854 describing Diehl Servomotors and related equipment.

Other Available Components:
D.C. SERVO SETS • RESOLVERS
MINIATURE PERMANENT MAGNET D.C. MOTORS

Diehl

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING CO.
Finderne Plant, SOMERVILLE, N. J
Atlanta Baltimore Boston Chicago Detroit New York Philadelphia Worcester



tor rotates disc at 175 fpm. Wheel feeder sections at both ends of the turntable align and steer packages into desired position. Occupying only 4-ft of floor space, turntable can rotate in either direction for 2-way operation. Cartons handled can be as large as 22 x 18-in., 24 x 14-in., or 20 sq in. Table also accommodates packages too small for successful transfer on most power curves. **Rapids-Standard Co., Inc.,** Dept. TT, 342 Rapistan Bldg., Grand Rapids, Mich.

Circle No. **13** *on Reply Card*

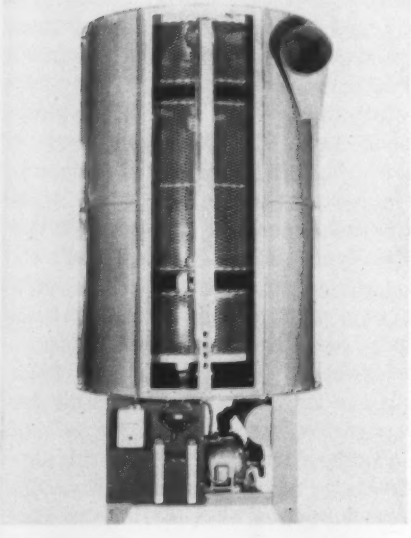
PRESSURE BLASTER

Automatic wet-blasting eliminates hand filing, grinding, wire brushing and chemical cleaning of small metal parts. Operator sits before unit and merely loads and unloads workpieces from rotating table which contains holding fixtures. Unit itself consists of a blast chamber where positioned guns finish the work, a rinse chamber where abrasive slurry is rinsed away, and an air-dry chamber. Easily accessible panel contains all necessary controls including a variable speed table drive regulator which governs amount of blasting time for work. To switch from one type of work to another necessitates only a change in the holding fixtures on the table and a repositioning of the blast guns. Two blast circuits are available; regular velocity which works on aspiration or suction principle, and high velocity which operates on pressure tank system. **Cro-Plate Co., Inc.,** 747 Windsor St., Hartford, Conn.

Circle No. **14** *on Reply Card*

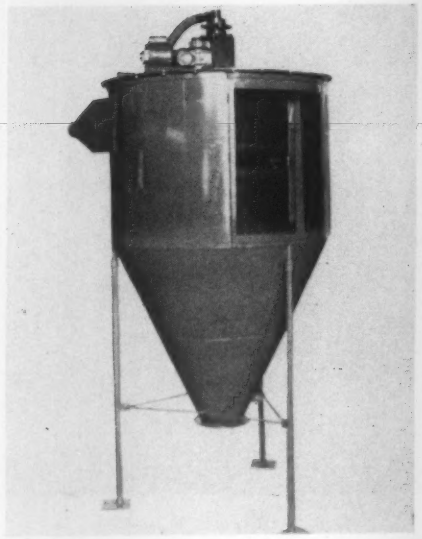
DUST COLLECTOR

A new dust collector, based on the principle of reverse-air-jet dust filtering, features a self-cleaning filter medium. Air enters cylindrical housing, outside of filter medium, through tangential air inlets which permit centrifugal dust preseparation. Air passes through filter medium into an inner filter cylinder. Actual filter medium is wool felt mounted over an expanded metal screen cylinder. A vertical, slotted, reverse-air-jet blow tube rotates between supporting cylinder and filter medium, and is supported by a central ball bearing mounted tube which, (1) supports the screen cylinder, (2) supports the reverse-air-jet blow tube which cleans the filter medium, and (3) conveys pressurized reverse-air-jet supply from positive displacement blower to a slotted blow tube. A tube, rotating outside the filter medium and in



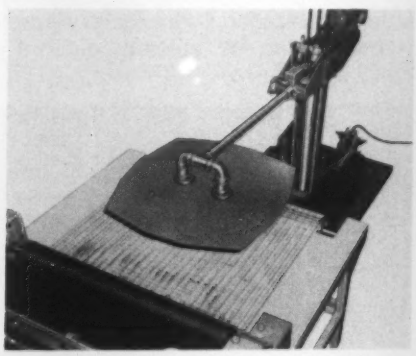
synchronization with and opposite slots in blow tube, catches dislodged dust and prevents redeposit of dust on the filter medium. Dislodged dust is conveyed directly into a hopper below. Available in capacities from 300 to 10,000 cfm, dust collector economically uses only one simple rotating assembly in the filter housing, and one electric motor drives both rotating blow tube and displacement blower.

A second model is available with top mounted, vertical shaft, centrifugal exhauster and self-contained installation. Machine can dissipate static electricity in enter-



ing dust, which might adversely affect filtering performance, when used in conjunction with grounded conductors. **Turner & Haws Engineering Co., Inc.,** 87 Gardner St., Boston, Mass.

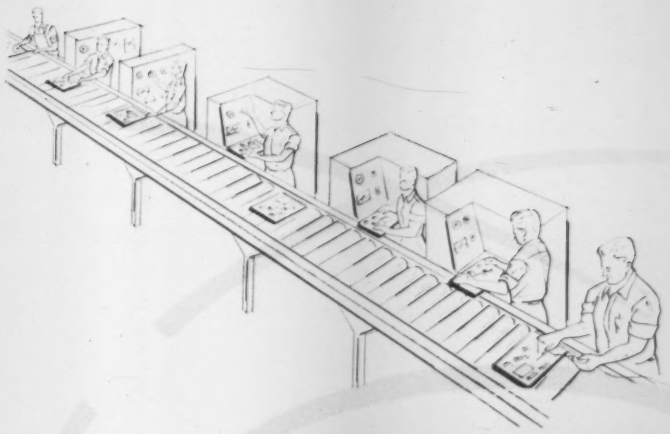
Circle No. **15** *on Reply Card*

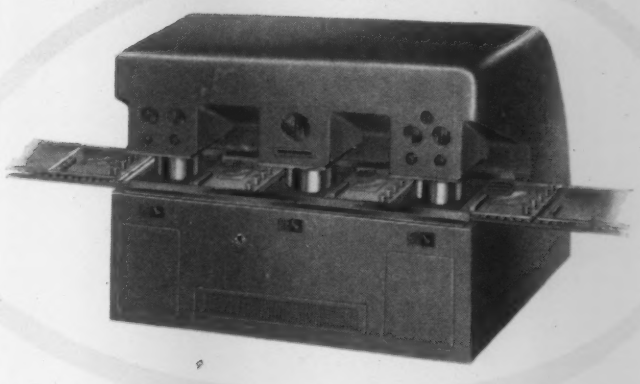


METAL SHEET LIFT

Designed to pick up at any level from floor to 36-in. height, an automatic vacuum lift will handle any nonporous metal sheets up to 40 x 40-in. at the rate of six sheets per minute. Machine contains its own vacuum plant. Arm is adjustable through 180 degree turn and can lay sheet exactly to position in any repetitive operation. Air consumption per cycle is approximately 0.60 cu ft. Automatic cycle is provided, but pushbutton control can be installed on a separate, convenient unit. Machine weighs 1800 lb and requires floor space 36 x 48-in., with 4 ft extension area for arm. **Union Tool Corp.,** 222 E. Market St., Warsaw, Ind.

Circle No. **16** *on Reply Card*





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Utilize Automation to cut the high cost of production line testing—increase speed—save space—eliminate labor and human error.

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CLEVELAND TRAMRAIL ...

a Leader in AUTOMATION

of Materials Handling for 30 Years

Automation as applied to overhead materials handling equipment is not new or magic to Cleveland Tramrail. For 30 years, we have engineered a wide variety of installations for handling materials automatically.

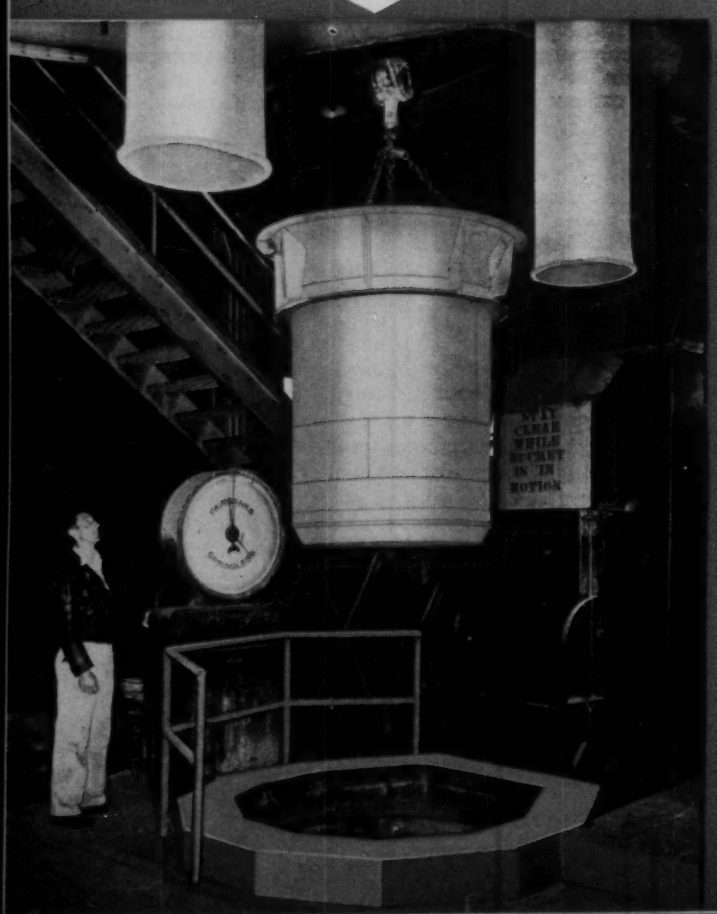
In operation today are Cleveland Tramrail installations that shuttle between two points delivering loads without need of operators — systems that dispatch materials to any of a large number of stations, as selected, empty and return, entirely automatically — equipment that is on the move all day long accumulating and delivering without any attendants whatsoever. The systems vary in type, size and complexity and have from one to hundreds of load-hauling carriers. They operate between points within a room, between floors of a building, outside between buildings, over roof tops and even over public highways.

TREMENDOUS SAVINGS

Automatic Tramrail systems enable tremendous savings — usually enough to completely pay for them within 12 to 18 months, or less — because they drastically reduce the man-hours required for materials handling and permit making the best use of building space. Widely separated operations can be integrated and carried out as though located adjacently. Remote areas, otherwise wasted, can be utilized efficiently.

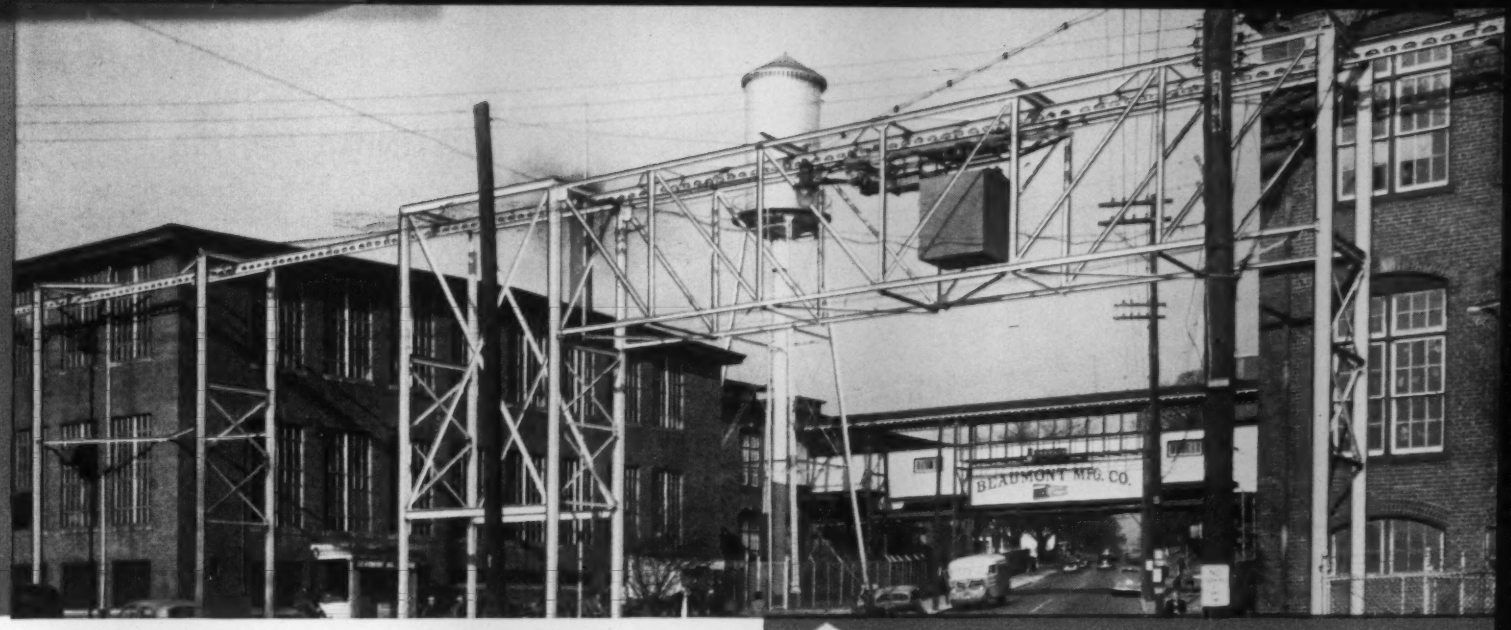
AUTOMATIC FURNACE CHARGING

Buckets with 2,000 lbs. of charge materials are delivered from weighing scale on one floor to melting furnace at an upper elevation, emptied and returned automatically by means of a Cleveland Tramrail Automatic Dispatch System.



AUTOMATIC TEXTILE BEAM HANDLING

80 man-hours are saved weekly by a Cleveland Tramrail Automatic Dispatch System which operates between two buildings, delivering beams directly from warpers to slashers without anyone accompanying.



Floor traffic — and frequently materials storage — can be transferred to ceiling space and thus effect savings in floor area and facilitate handling.

Regardless of the nature of your business, most likely the principles of automation can be profitably applied to the handling of materials in your plant. With a wealth of experience in this field, Cleveland Tramrail engineers stand ready to serve you. Your inquiries are invited without obligation.

CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
1386 EAST 284th ST., WICKLIFFE, OHIO

AUTOMATIC HANDLING OVER HIGHWAY

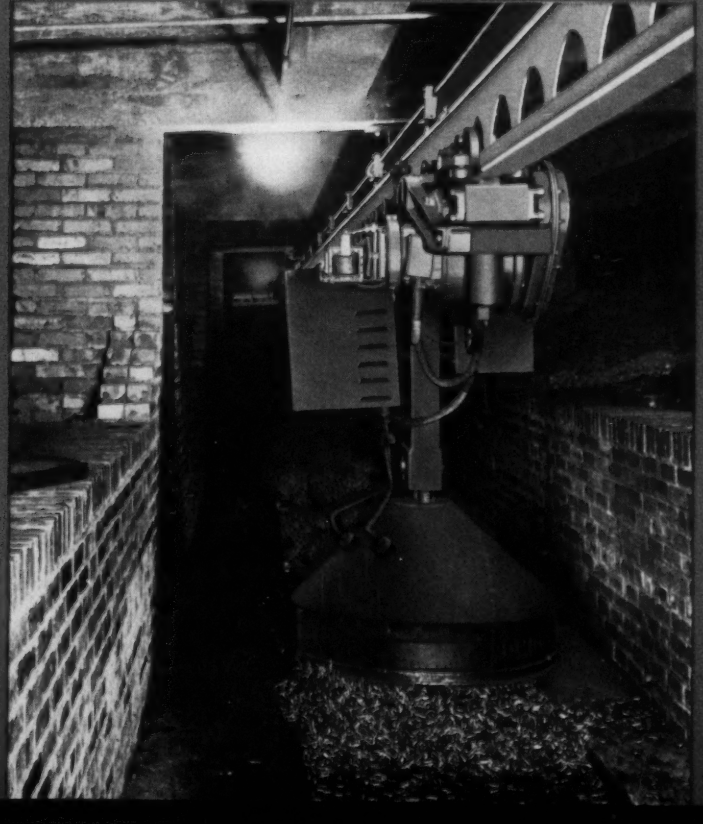
Materials are carried back and forth between buildings located on both sides of a principal thoroughfare by automatic dispatch carriers which operate on three Cleveland Tramrail track systems.

AUTOMATIC STEEL SCRAP DISPOSAL

One carload of metal chips is picked up daily and moved to a bin at a railroad track by an automatic magnet-carrying system. The scrap comes from metal-cutting machines on floor above. The system is in operation 12 hours a day without attendants.

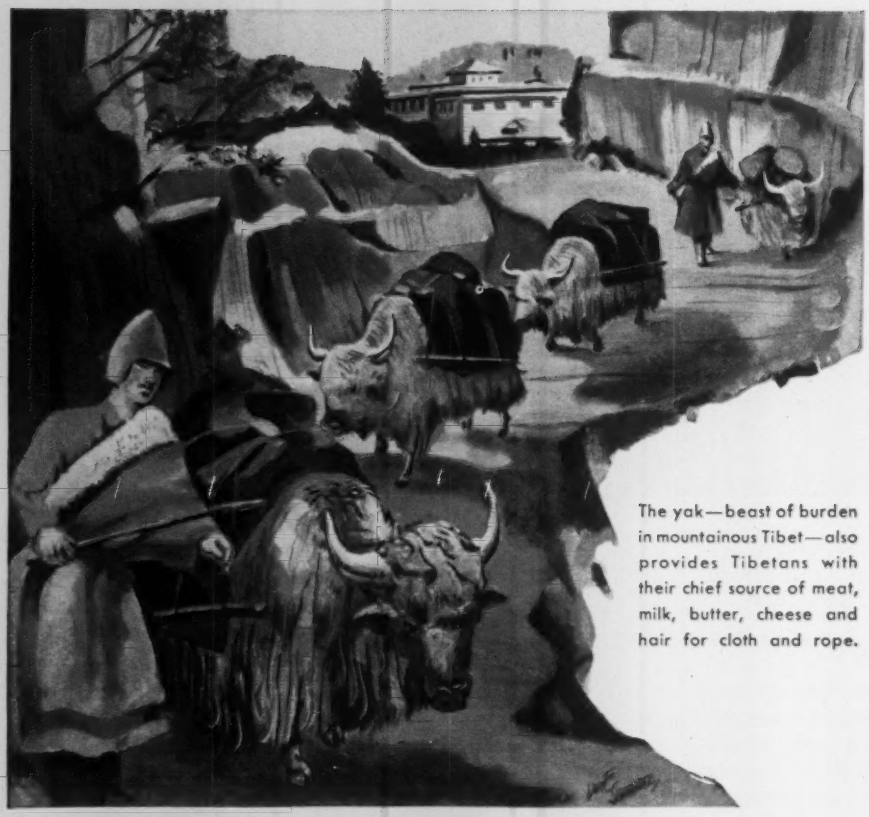
AUTOMATIC SAND DISTRIBUTION

Sand is distributed in a foundry from the muller to molders' stations by a Cleveland Tramrail System which has a 24 cu. ft. bucket that travels on a double track and discharges wherever sand is called for.



AUTOMATIC PAPER SCRAP HANDLING

A carrier with two buckets delivers scrap paper cuttings from the first floor to 15 bins on the top floor. When the carrier reaches a pre-selected station it stops and bucket empties by turning. Carrier then proceeds to bin selected for second bucket. After it has emptied, carrier returns to starting point.



The yak—beast of burden in mountainous Tibet—also provides Tibetans with their chief source of meat, milk, butter, cheese and hair for cloth and rope.

MULTI-PURPOSE CONVEYORS

Modern industrial conveyors are frequently designed to accomplish more than one useful production operation.

That's why some of Allied's most interesting and unusual installations have been those that best illustrate *Allied* ability and versatility for creating multi-purpose material handling equipment.

Allied have been Automation specialists for years—their installations include various types of conveyors, multiple transferring equipment, and highly engineered, fully automatic material handling systems.

If you are faced with a peculiar kind of material handling problem, you can confidently expect Allied to come up with a dependable and efficient solution.

PIONEERS IN AUTOMATION . . . *the design and fabrication of fully automatic mechanical handling systems*

One example of highly specialized Multi-purpose Equipment is this combination Tire Inflater, mounter and conveyor, designed and built by Allied for an automobile manufacturer.

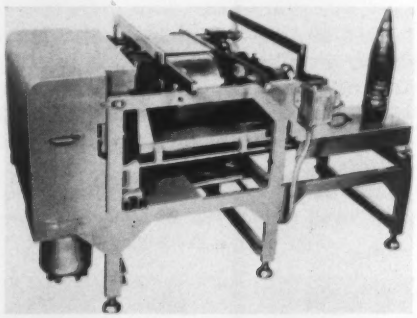
For further information request Allied Catalog 953

ALLIED AUTOMATION DIVISION
ALLIED STEEL and CONVEYORS, INC.
17371 Healy Avenue, Detroit 12, Michigan

CYLINDER PRINTER

A new automatic marking machine for printing on heavy cylindrical objects can be installed as part of a production line for completely automatic operation, or can be manually fed, if desired. Originally developed for marking loaded 75-105M projectiles, the machine can adapt to imprint cans, containers and similar objects of a cylindrical nature.

As part of a production line, the unit receives, prints, and ejects the objects being marked. The inking and printing mechanism slides out from the side of the machine for easy access when the unit is built into a conveyor. The printing legend and colors

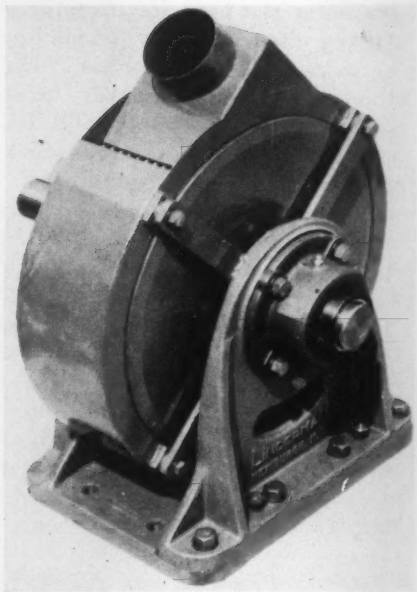


are easily changed, and the reservoir inking mechanism is quickly cleaned and adjusted. Inks and marking compounds come in a range of colors for a variety of finishes or materials. Cylinder to be printed can range from 3 to 10 in. in diameter and weigh 5 to 100 lb. Imprint area can be as large as 9 x 9 in., and larger areas can be accommodated where required. Explosion-proof equipment can be furnished, if necessary. Electric drive is self-contained. **Markem Machine Co.**, Congress St., Keene 40, N. H.

Circle No. **17** *on Reply Card*

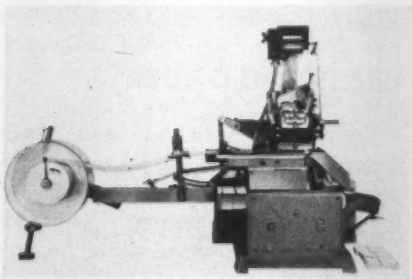
BRAKE COOLER

Controlled forced air cooling permits greater range of service for industrial s a f e t y and tension brakes. When heat is generated by load or surrounding temperature rises, high velocity, low pressure air lowers the brake drum and lining temperature and counteracts expansion, extending serv-



ice life of the brake and increasing its operating accuracy and effectiveness. Air cooling can be built in or can be obtained in self-contained models. Six mounting positions are possible with the self-contained model, and change from one mounting position to another can be accomplished easily in the field. Air is supplied by a standard centrifugal fan or blower and makes one circulation through the housing before exhausting. Incoming air opposes direction of drum rotation to obtain as great a relative velocity as possible—as high as 6000 fpm is obtained regularly. Air supply source is external, therefore cooling efficiency is independent of rate of drum rotation. **Linderman Devices, Inc.,** 5 Robinson Ave., Newburgh, N. Y.

Circle No. **18** *on Reply Card*



AUTOMATIC MARKING

Designed for printing notched tickets, tags and labels in roll, fan folded or strip form, a new marking machine features a feed mechanism which insures exact printing registration. The machine

Automatic "Muscle"

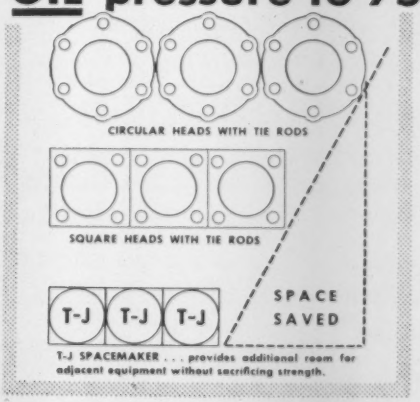
for PUSH-PULL-LIFT JOBS!

New
COMPACT DESIGN SAVES UP TO **40%** SPACE!

Off shelf delivery!

T-J Spacemaker CYLINDERS

OIL pressure to 750—AIR to 200 P.S.I.


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
T-J
T-J
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SPACE SAVED
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Now the sensational new T-J Spacemaker sets the pace in compact cylinder design and efficient performance!

New "Self-Aligning" adjustable oil cushion means faster acceleration and better cushion than ever before . . . New T-J Super Cushion Flexible Seals for air insure positive cushion with automatic valve action for fast return stroke.

More plus features include—heavy wall, precision honed, hard chrome plated, seamless steel body . . . leakproof cylinder head to body construction . . . heavy duty, high-tensile, *hard chrome plated piston rod.* Write for bulletin SM-454-2. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS . . AIR AND HYDRAULIC CYLINDERS . . CUTTERS . . CLINCHORS

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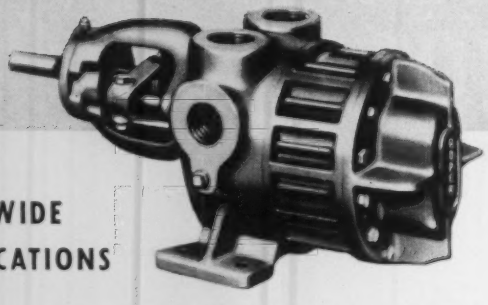
ROPER ROTARY PUMPS

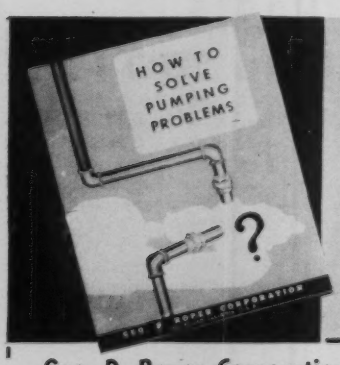
for Positive Results



SERIES F PUMP

MODELS FOR AN EXCEPTIONALLY WIDE RANGE OF APPLICATIONS

SERIES	TYPICAL USES	PRESSURES	SIZES
3600	All Petroleum Handling Grease Compounding Oil Circulating General Transfer	to 60 P.S.I.	40-300 G.P.M.
F	Pressure Lubrication Hydraulic Power Fuel Transfer Lube Oil Transfer	to 300 P.S.I.	1-300 G.P.M.
K	Pressure Lubrication Hydraulic Service Industrial Oil Burner Fuel Supply	to 150 P.S.I.	¾-50 G.P.M.
H	Hydraulic Power Test Equipment Pressure Lubrication High Pressure Coolant	to 1000 P.S.I.	5-75 G.P.M.



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A valuable guide covering important fundamentals of estimating requirements of the average pumping job. It includes tables, charts, sample problems, and other pertinent data. SEND COUPON BELOW.

Geo. D. Roper Corporation, 228 Blackhawk Park Ave., Rockford, Ill.

Please Send Booklet—"How to Solve Pumping Problems"

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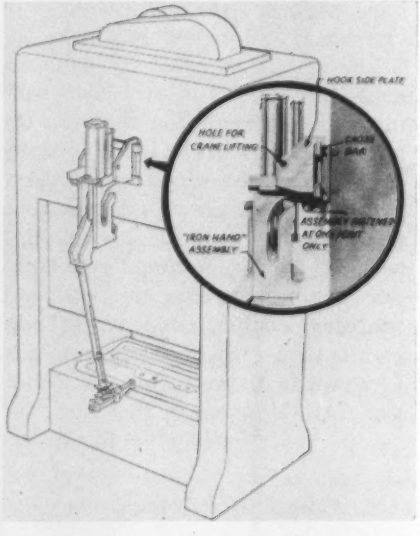
ROPER *Rotary Pumps*

eliminates the need for inventories of preprinted labels or tickets and is faster and neater than hand stamping. Machine will print complete label detail or will imprint on partially printed stock, as required, in exact quantities.

Pieces are printed at the rate of 80-100 per minute and can be cut off and stacked or rewound in a roll. Maximum imprint area is 2 x 2½-in., and tickets in rolls, feeding into machine, can be as large as 2¼ x 3¾-in. Many sizes and styles of type are available. Type is quickly changed. Inks are fast drying and come in a range of colors. Special designs or trade marks can be duplicated.

The machine is powered by a ¼ hp gear reduction motor. It occupies bench space 20 in. deep and 23 to 40 in. wide depending on size of paper roll. **Markem Machine Co.**, Congress St., Keene 40, N. H.

Circle No. **19** *on Reply Card*

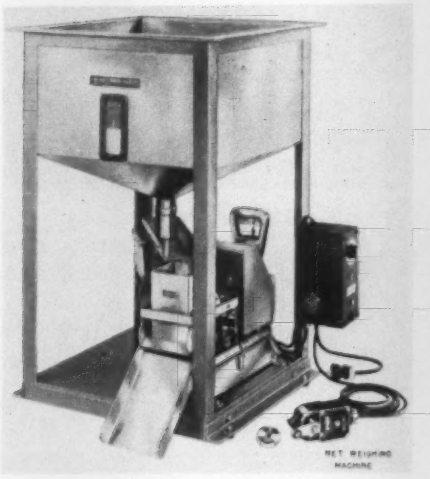


PRESS UNLOADER

Unloaders may be transferred from one press to another by means of a specially designed mounting arrangement. Unloaders remain in service while presses are down for repairs or die changeover. Entire assembly, known as the "Iron Hand", is equipped with specially shaped side plates which hook over cross bars of a permanently attached bracket on the press. Mounting is fastened and locked at only one point. Transfer of mechanism is

made by crane via holes drilled in side plates. **Sahlin Engineering Co.,** 267 Ferndale, Birmingham, Mich.

Circle No. **20** *on Reply Card*



PLASTIC MOLD FEED

A weigh-feeding machine installed above a plastic injection molding machine in place of an injection machine hopper will feed precise amount of plastic into molder. Employing a "starved feeding" method, injection plunger bottoms at extreme limit of stroke rather than against a cushion of excess plastic. When material requires a cushion, machine will maintain one of constant dimension. Advantages over normal hopper injection are savings in plastic, faster injection cycle because of higher injection pressure, dimensional stability of the molded part, reduced internal stress because of even distribution of pressure within the die, and reduction of rejects. **Exact Weight Scale Co.,** 944 West 5th Ave., Columbus, Ohio.

Circle No. **21** *on Reply Card*

CUT-OFF MACHINE

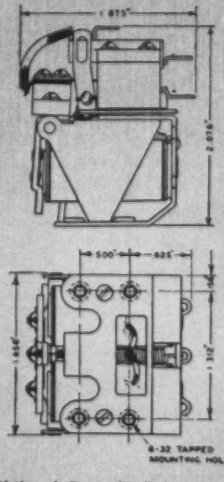
Designed for a paper tubing manufacturer, this cut-off machine will cut tube lengths as tubing comes out of spiral winder, eliminating preliminary sawing operation. Unit consists of oscillating carriage which contains motor driven rotating chuck and air actuated cutting knives operating against a floating mandrel inside the tube. Machine will cut units from 2 to 6-in. OD,

Where **SHOCK** *and* **VIBRATION** *are a Problem . . .*

ENGINEERS CHOOSE the rugged *Phil-trol* 27 RELAY

For AVIATION and ELECTRONIC INDUSTRIES

TYPE 27QA—3 POLE



Phil-trol Type 27 Relays are available in 1, 2, 3, 4 or 5 pole, single or double throw. Operating voltage up to 230 D.C., resistance up to 13,400 ohms, minimum operating current is .001 amps. Available enclosed in dust cover or hermetically sealed.

■ Proved performance of Phil-trol 27 Relays in many vitally important applications has built great demand for this sturdy, sensitive and highly efficient relay. For instance, they are used for: propeller pitch control . . . cabin pressure and temperature control . . . guided missiles . . . computers . . . communication equipment . . . and many other electronic devices.

Phil-trol 27 Relays have unusual features like two-coil construction, which allows greater operating force for a given power input, and also completely eliminates magnetizing force losses at the armature hinge. The rigid frame and balanced armature design provides stability under conditions of high acceleration, severe vibration or shock.

For complete details on all of the many Phil-trol Relays available, write for the new Catalog shown below.

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Please send me a free copy of the new Phil-trol Relay and Actuator Catalog. Also, please arrange to have a Phil-trol Sales Engineer call on me.

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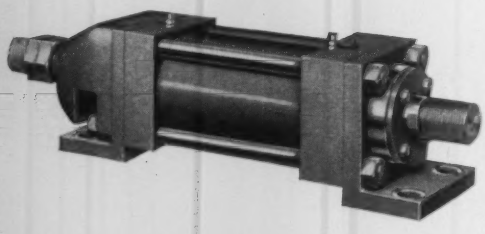
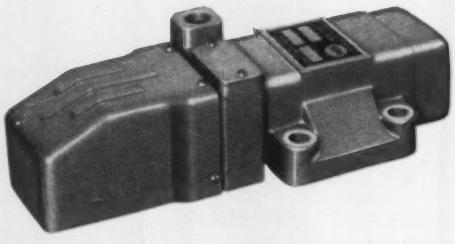
Realistic Planning

CALLS FOR PRACTICAL EXPERIENCE

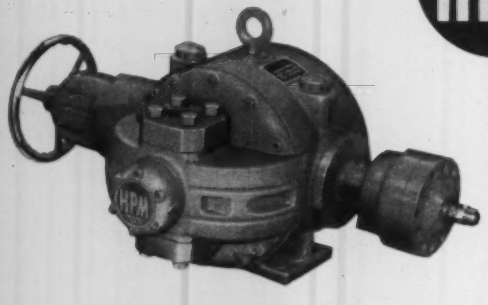


AIR AND OIL
HYDRAULIC CYLINDERS

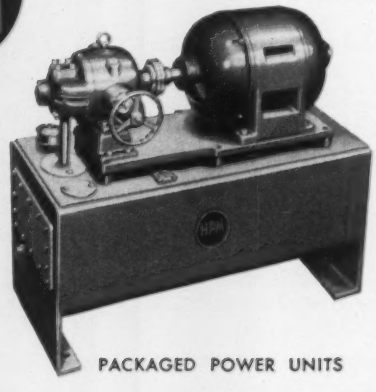


AUTOMATICALLY
CONTROLLED VALVES

HPM



VARIABLE VOLUME
HYDRAULIC PUMPS



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For over three-quarters of a century H-P-M engineers have designed equipment — and motions — for varied requirements. Now, with a complete line of air and hydraulic components as part of our standard line you are assured of complete responsibility for your automatic systems. The hydraulic cylinders, valves, pumps and power units illustrated are typical of the air and oil hydraulic equipment in the H-P-M line. Call in the H-P-M Field Engineer in your locality when power, or the control of power, is your problem. The experience of the H-P-M organization will be of real assistance.

This 28-page condensed catalog covers the complete H-P-M line of hydraulic components. Write for your copy.

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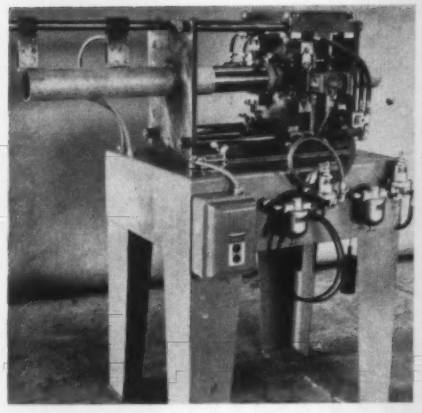
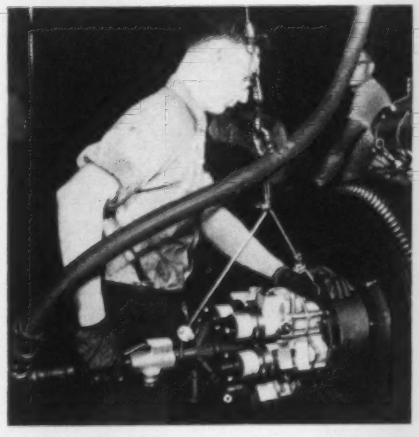
HPM

HYDRAULIC
POWER
DIVISION
THE HYDRAULIC PRESS MFG. CO.
MOUNT GILEAD, OHIO, U. S. A.



and up to 3 ft, 6-in. long. Addition of extension arm permits cutting of greater lengths. **Gordon & Morgan Machine Co.,** 3725 Touzalin Ave., Lincoln, Neb.

Circle No. 22 on Reply Card

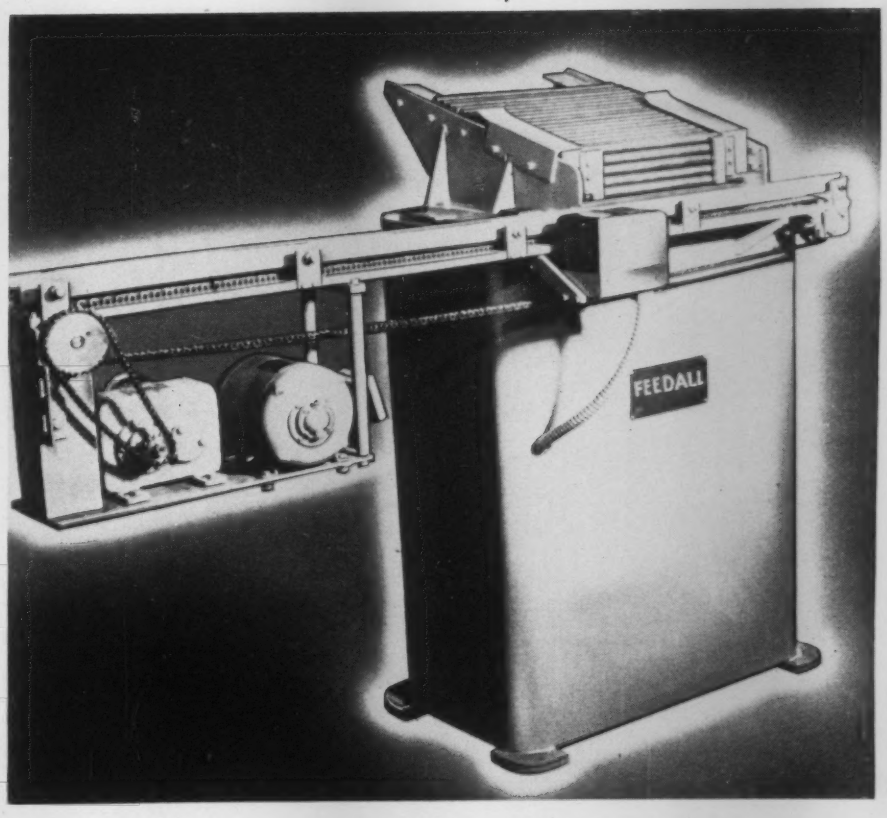


MULTIPLE NUT RUNNING

A completely automatic packaged unit runs multiple nuts simultaneously in the time usually required to run a single nut. Nuts are run to a predetermined stall, giving uniform torque and quality control. Machine's tools can be built for any number of nuts in any pattern desired. An Ingersoll-Rand two-stage 125 hp XLE compressor powers the machine and a pushbutton starts operation.

The nut runner is applicable to any product requiring the setting and tightening of multiple nuts. It adapts especially well to assembly of automotive engines, transmissions and differentials, and to the manufacture of machine tools, electrical appliances, furniture and aircraft engines. **Ingersoll-Rand,** 11 Broadway, New York 4, N. Y.

Circle No. 23 on Reply Card



MAGAZINE LOADER

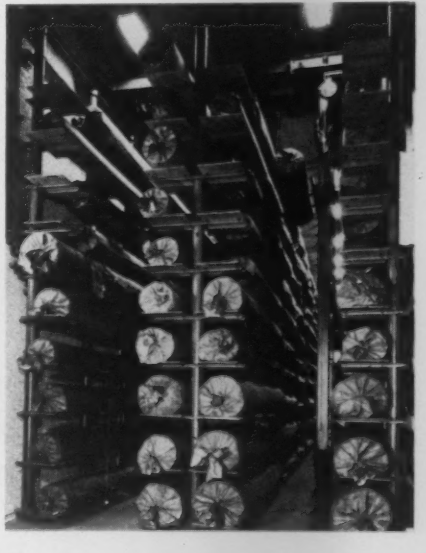
Magazine loader automatically feeds long cylindrical work to centerless grinders, special polishing or inspection machines. Parts are loaded, delivered to built-in conveyor and cycled by means of a photoelectric relay mounted on the conveyor. Variable speed drive on conveyor controls feed rate. Unit is mounted on fabricated steel base which houses electric and air controls. Parts can range from $\frac{5}{8}$ to $1\frac{1}{2}$-in. in diameter and from 12 to 24 in. in length in model pictured. **Feedall Machine & Engineering Co.,** 38399 Pelton Rd., Willoughby, Ohio.

Circle No. 24 on Reply Card

STORAGE SYSTEM

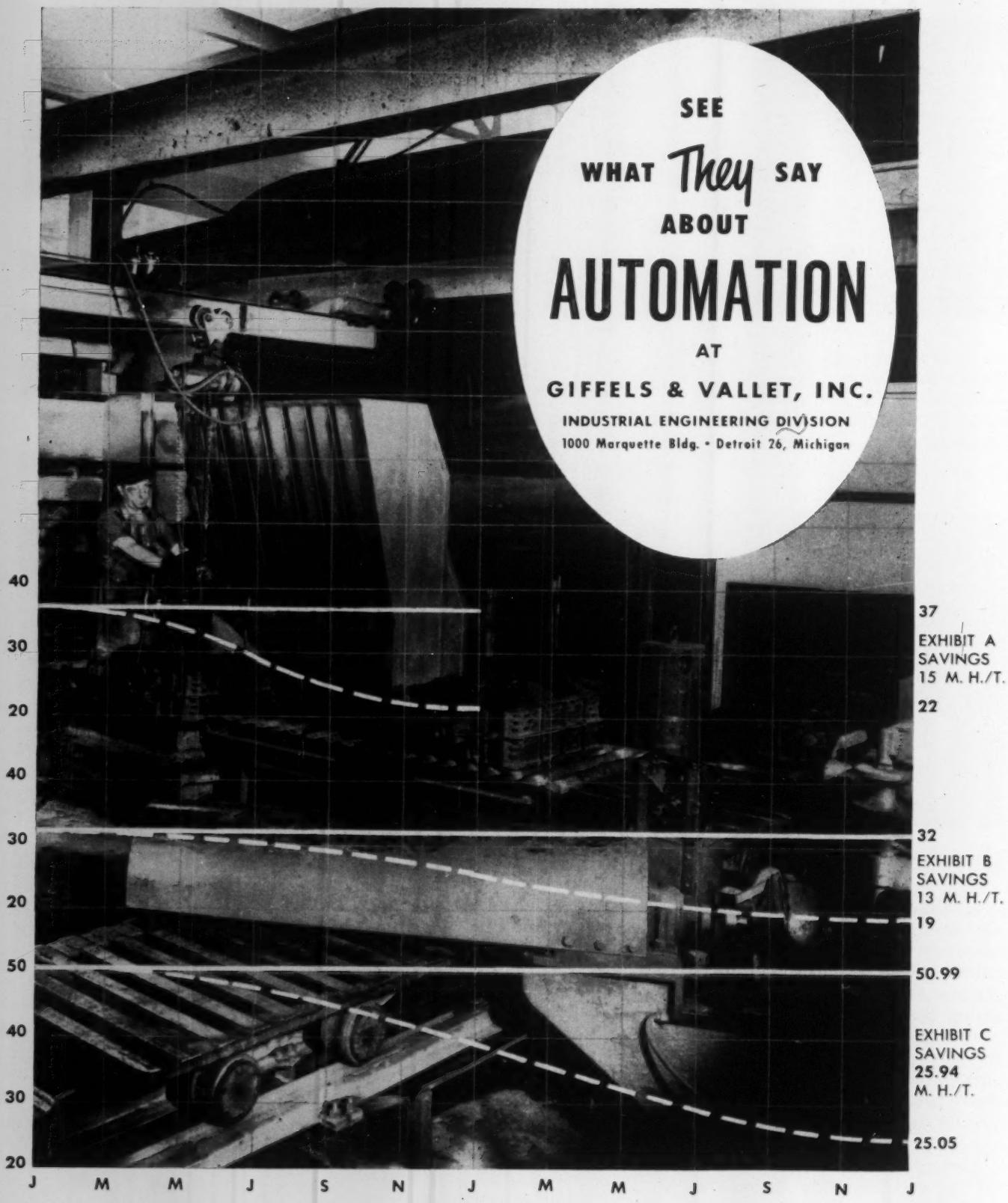
Automatic storage system features a self-leveling device which will stop hoist at selected rack on a level to permit loading or unloading instantly without time-consuming maneuvering. Crane operates in extremely narrow aisle, serving both sides and providing 100 per cent selectivity of materials.

System illustrated shows storage of paper rolls as long as 15-ft and weighing 1000 lb each. Rolls are stacked 27-ft high to utilize nearly all of the cube distance from floor to roof trusses. Crane operates on rails mounted on top of storage racks and maneuvers in 50-in. wide aisles. Four basic movements of the system are bridge, trolley travel, lifting, and 360° column



rotation, and any or all of these motions can be manual or automatic. **Chicago Tramrail Corp.,** 4000 Washington Blvd., Chicago 24, Ill.

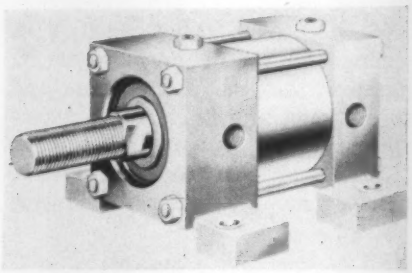
Circle No. 25 on Reply Card



THREE ACTUAL EXAMPLES OF SAVINGS IN MAN HOURS PER TON OF PRODUCTION. GIFFELS & VALLET HAS BEEN ENGINEERING AUTOMATION FOR INDUSTRY FOR OVER 25 YEARS.

We will gladly, without obligation, discuss your production problems and the assistance we could render.

AUTOMATION NEW COMPONENTS



Air Cylinder for Automation

Heavy-duty line of air cylinders is especially suited for automatic applications, for general use on conveyors, dies, machine tools, presses and welding machinery, and for foundry, oil field and steel mill equipment. Cylinders will operate at pressures up to 200 psi. Extra large, hardened piston rods and double porting for extreme high speeds are featured. Cylinders have extra long cushions, interchangeable check and cushion adjustment valves, and rolled steel end plates, and are available with five types of mountings. A unique cartridge type rod packing and bearing makes possible quick change of packing with minimum down time. Eight bore sizes range from 1½ to 6-in. **S-P Mfg. Corp.**, 12415 Euclid Ave., Cleveland 6, Ohio.

Circle No. **26** *on Reply Card*

Heavy Duty Limit Switch

With contact pressure more than twice that of most limit switches and with greatly reduced operating pressure, a new heavy duty limit switch is said to be best switch perfected to date by its designer, M. C. Jeffrey. Loxswitch is a single-pole, double-throw, double-break switch with a trigger-type mechanism which provides fast and accurate break. Accuracy within 0.03° is maintained without lubrication. Contact bars are of solid silver, weigh only 1/10-oz, can be reversed and reinstated for double life. The only "floating" components in the switch, these bars are carried in a balance rotor and locked in each closed position under 10 oz spring pressure to provide vibration-proof circuit. Operating pressure is 45 in.-oz without return spring, and 185 in.-oz with return spring and

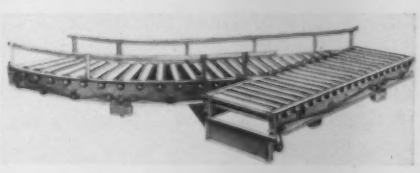
full overtravel. Balanced rotor, graphite bronze bearing, and second "outboard" shaft bearing add to switch's long mechanical life. Switch has passed 25,000,000 actuations without overtravel, and 20,000,000 with 20° overtravel, operating at 182 times a minute. Wiring terminals are separated from moving parts. All stationary contacts can be changed in 30 seconds. Aluminum housing has three optional mountings to fit most existing installations. Normally assembled for lever operation in one direction with spring return, Loxswitch is altered easily for opposite operation or for maintained contact in either direction. Lever trips with a 10° motion, has 25° useable overtravel on either side of operating range. Size is 2¼ x 1¾ x 5¼-in.

Two additional switches are available in this line, a double pole snap action switch and a neutral position switch. Double pole switch is single throw, operates in clockwise or counter clockwise direction, can be set for "N.O." or "N.C." spring return, or for "N.O.-N.C." maintained contact. Neutral position switch is single pole, double throw, is assembled for neutral position operation with both circuits normally open and lever in a central position. This is a slow make and break switch for use in pilot circuits. **R. B. Denison Mfg. Co.**, 4220 Hough Ave., Cleveland 3, Ohio.

Circle No. **27** *on Reply Card*

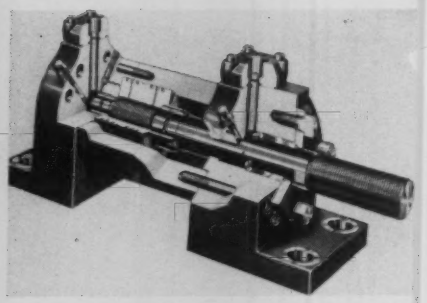
Converging Conveyor "Y" Unit

A compact, power driven "Y" unit eliminates clogging on converging conveyor lines and can be incorporated into all types of package conveyor lines, grounded or suspended. Consisting of a 90 degree roller conveyor curve and a 5-ft live, straight roller conveyor section, the unit is chain driven by a single ½ hp gearhead motor through universal joints. Speeds



up to 90 fpm are feasible. Plastic guard on either side of unit permits observation of moving parts and prevents catching of worker's clothing in chains or sprockets. **Harry J. Ferguson Co.**, 115 West Ave., Jenkintown, Pa.

Circle No. **28** *on Reply Card*



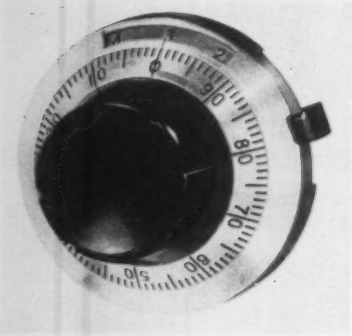
Hydraulic Cylinder Line

Line of cylinders offers more than 800 models with variety of mountings which includes foot, side lug, centerline, clevis, base, flange, rabbet, trunnion and subplate. All cylinders have heavy duty construction, spring loaded piston rod packings for positive sealing, and flexible mounting design to permit reuse of the unit. Male or female, single or double end piston rods, with or without cushion, and many combinations of mountings are available. Standard or 2:1 piston rods in ground and polished steel, chrome plate, hardened, or hardened and chrome plate can be ordered in the 2000 and 3000 series. Bore sizes are 1½ to 12-in. but larger sizes can be ordered, as well as such unusual models as single acting, collapsible or telescoping cylinders. Series 300 is designed for 150 psi air or 300 psi oil hydraulic service. Series 2000 and series 3000 (illustrated) are designed for 2000 and 3000 psi oil hydraulic service respectively. Most standard models in all series can be ordered for water hydraulic service. **Hydraulic Power Div., Hydraulic Press Mfg. Co.**, Lincoln Ave., Mount Gilead, Ohio.

Circle No. **29** *on Reply Card*

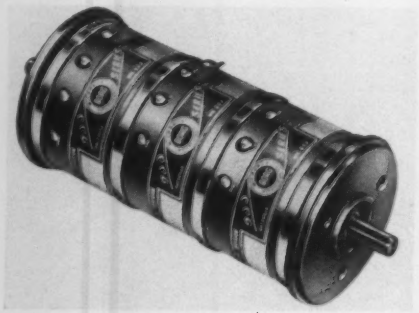
Counts Component Rotation

Duodial counts turns of a rotating component accurately to a hundredth of a turn. Model consists of two coaxial dials and a



black nylon knob integral with inner dial. Inner dial is calibrated to count hundredths of each turn, and outer dial to count number of complete turns, up to 15. Knob and inner dial fasten directly to shaft of rotating component. Since duodial can be rotated by either knob or shaft, it can count power-driven turns and set to a desired value. Critical readings are free from backlash. Lock is vibration-proof. A set of intermittent gears between inner and outer dials facilitates easier reading and reduces torque. Models fit ¼ or ⅛-in. diameter shafts and nominal weight is 2¾ oz. **Helipot Corp., Beckman Instruments, Inc.**, 916 Meridian Ave., South Pasadena, Calif.

Circle No. **30** *on Reply Card*



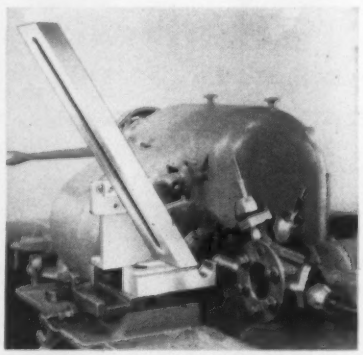
Three-Turn Potentiometers

Because of its low starting and running torque, a flexible 3-turn precision potentiometer may be used instead of a single-turn unit with a consequent gain in accuracy and resolution. Either or both mechanical stops may be used as phasing points because drive assembly is adjustable. Adjustability also provides greater accuracy in four basic types of linearity. One to five-gang models are available with single or double shaft, servo or bushing mount at either or both ends. Extra long life, no backlash between mechanical and electrical rotation, fine resolution as a result of longer Kohlrausch winding, and welded terminal leads are added selling features of these new potentiometers which company calls micropots. **Borg Equipment Div., George W. Borg Corp.**, 120 So. Main St., Janesville, Wis.

Circle No. **31** *on Reply Card*

Semiautomatic Attachment

A magazine attachment for automatic screw machines permits semi-automatic performance of second operations. Unit consists of a magazine for holding and carrying work to the chuck, cams and form tools, and a chuck complete with ejector and inserting tool. Mounted on the front cross slide of the machine, magazine requires



no extra drilling or fitting for attachment. One operator handles additional automatics while keeping chute in magazine filled. Parts can be ejected and dropped in work pan automatically. Odd shaped parts, heretofore difficult to magazine, are handled successfully. **Alco Tool Co.**, 152 Birdseye St., Bridgeport 4, Conn.

Circle No. **32** *on Reply Card*

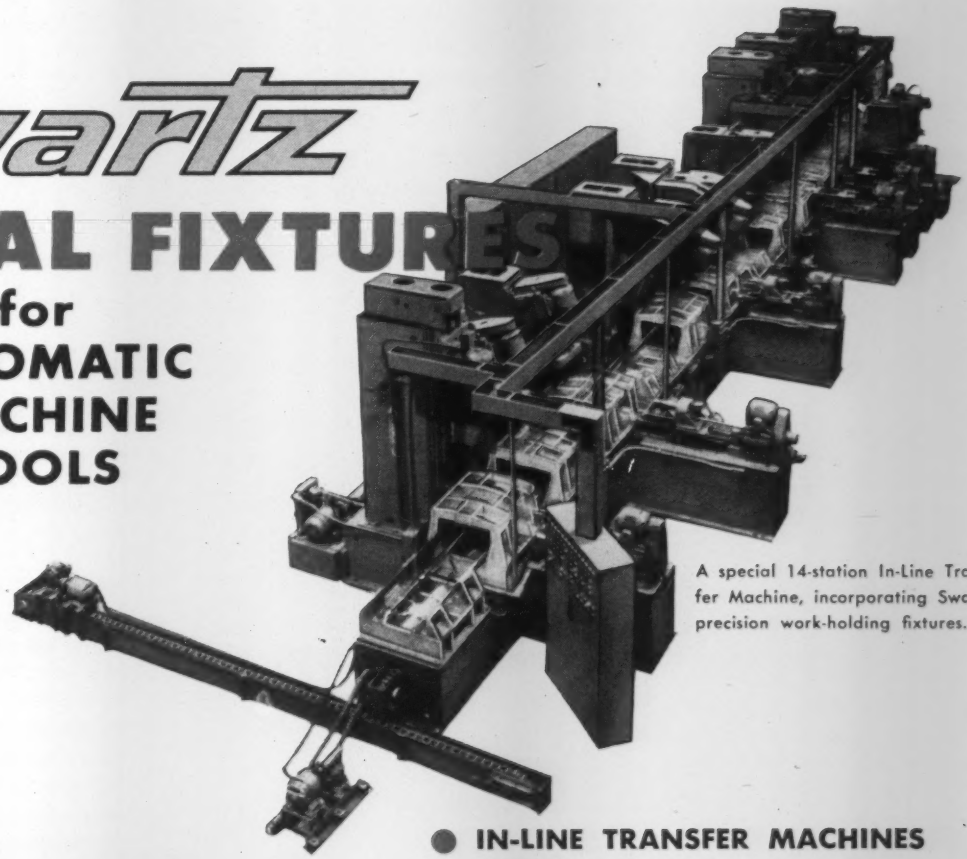
"Super" Electric Fuel Pump

An electric fuel pump for trucks, busses and all gasoline engines comes in two models, six and twelve volt. Pump is insulated from the case and has both positive and negative terminals so that it may be used on either ground system. Full capacity exceeds 35 gph without restriction in the line. The pump operates at only 250 strokes per minute (up to 75 per cent less than other pumps), therefore works less, runs cooler, lasts long-

Swartz

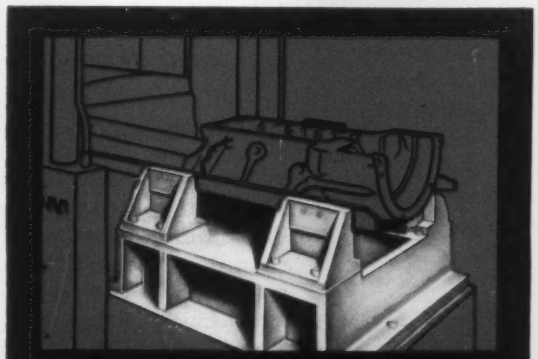
SPECIAL FIXTURES

for AUTOMATIC MACHINE TOOLS

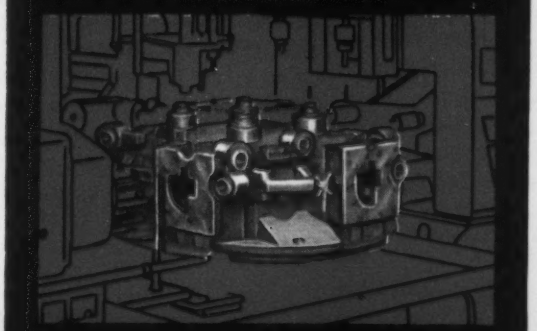


A special 14-station In-Line Transfer Machine, incorporating Swartz precision work-holding fixtures.

- **IN-LINE TRANSFER MACHINES**
- **ROTARY INDEX MACHINES**
- **TRUNNION INDEX MACHINES**
- **SINGLE-STATION MULTIPLE-OPERATION MACHINES**



Station No. 1—Special 14-station In-Line Transfer Machine. Swartz fixtures were specified for dependable, on-the-job fixture performance.



Here is a 4-station Rotary Index Machine, equipped with Swartz fixtures. Swartz fixtures were specified for maximum service and dependability.

There are many advantages in specifying Swartz precision work-holding fixtures . . . advantages which are shared alike by both buyer and builder of automatic machine tools.

Of particular importance, is the seasoned experience, and specialized know-how which Swartz has gained through more than 30 years of fixture-building service to the machine tool industry. This experience and skill, together with the modern facilities needed to do the job, make Swartz service *complete* . . . from part print to finished fixture!

There are other advantages, too, in specifying and using Swartz fixtures. It will pay you to get the facts! A Swartz engineer will be glad to discuss your fixture requirements, and point out the many ways Swartz service can work for you *profitably*.

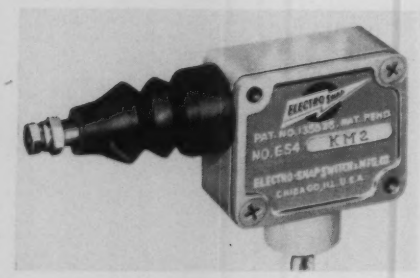
Write Today **Swartz service is outlined in this interesting new brochure, "Advancing Automation." A copy will be mailed on request.**

SWARTZ TOOL PRODUCTS
Division of Jefferson Corporation
13332 FOLEY AVENUE • DETROIT 27, MICHIGAN

Designers and Builders of: Pump Jigs • Standard Fixtures • Fixture Locks • Special Fixtures for Automatic Machine Tools.

er and costs less per mile. Rate of operation is dependent upon engine demand for fuel rather than engine speed, as in mechanical pumps. Self-priming, the pump will speed up when vapor is in the line until all vapor is expelled. This feature insures gasoline in the carburetor before engine turns over, results in quick starts with less drain on battery and no vapor lock. Basically a standard diaphragm-type pump, the new model employs a larger coil, powerful spring and efficient valving to increase capacity and fuel delivery pressure. Heavy-duty toggle-type switch with fast-breaking tungsten and platinum contact points and an inductance shunt to eliminate arcing, pitting and burning of points double life expectancy of pump. **Stewart-Warner Corp.,** 1826 Diversey Pkwy., Chicago 14, Ill.

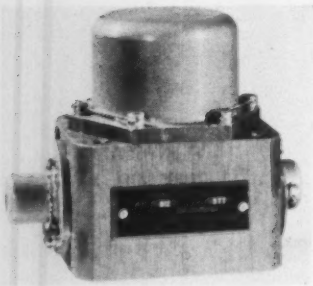
Circle No. **33** *on Reply Card*



One-Way Impulse Switch

A one-way impulse switch will send controlling electrical impulse to a solenoid or starter, then drop out of circuit and not be tripped upon plunger return. Switch thus eliminates need for time delay relays, actuating dogs and additional switches. Single pole, double throw model is rated at 10 amps, 125/250 v ac for two circuits. Neoprene boot seals actuating plunger against water and dust, retains flexibility in a temperature range of −67 to 160° F. Silicone boots can be furnished when temperature varies further. Plunger length can be varied up to ⅜-in. This snap-action switch is best adapted to control of automatic sequencing movements, safety interlocks, positioning switches, limiting action of machine members and initiating time cycles. **Electro-Snap Switch & Mfg. Co.,** 4218-30 W. Lake St., Chicago 24, Ill.

Circle No. **34** *on Reply Card*



Servo Valves

A special series of valves is designed for use in high performance, electro-hydraulic, positional type servo systems such as guided missile and aircraft flight controls, radar scanning actuation and automatic packaging equipment. These valves are proportional, electrically actuated, hydraulic, 4-way units capable of controlling output flow from 0.5 to 8 gpm in hydraulic systems of 1000 to 3000 psi, with signal input of differential current ±8 milliamperes. Lower or higher signal levels are available if required. Time constant between input current and output flow is approximately three milliseconds which permits highly accurate and responsive control system. Continuous oil flow of 0.1 gpm runs through a frictionless, first stage, push-pull hydraulic amplifier. Oil is internally filtered, applied as differential hydraulic pressure to valve spool. **Moog Valve Co., Inc.,** Proner Airport, East Aurora, N.Y.

Circle No. **35** *on Reply Card*

Automatic Drilling Unit

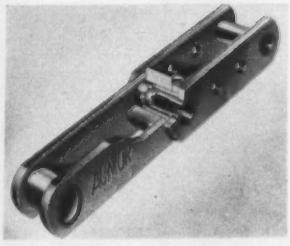
A self-contained drilling unit automatically advances, drills under accurately controlled conditions, retracts and shuts off at a touch of the control valve. A sensing-type advance will move the drill to work and then shift to

preset drilling feed. When skip drilling, the drill returns to rapid advance after each break-through. Automatic peck-drilling will retract the drill as often as needed to clear flutes. Various models have speeds ranging from 250 to 15,000 rpm, and speed of air motor may be adjusted while maintaining full thrust. Strokes are from 2 to 7-in. **Keller Tool Co.,** 1333 Fulton St., Grand Haven, Mich.

Circle No. **36** *on Reply Card*

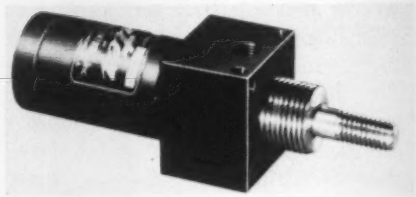
Hollow Pin Conveyor Chain

A conveyor chain to meet the requirements of continuous processing equipment features a hollow tubular pin, providing a large diameter pin for strength and a simple means of fixing attachments to the chain. Wide variety of buckets, trays and cross flights form actual carriers and are attached by retainer rings at ends of hollow pins. Cylindrical bushings and pins are forced into round holes a few thousandths of an inch smaller than the parts, and force so obtained resists any efforts at turning. "Fidgeting" and turning thus prevented cannot cause excessive wear or chain failure. Wearing surfaces are case hard-



ened and then ground to give glass-hard polished surface, very large in proportion to the load capacity of the chain, for turning of chain joints. Accuracy of pitch, ranging from 2 to 6-in., insures correct meshing. Chain is not detachable. **Acmor Conveyor Chain Co.,** 17100 Miles Ave., Cleveland 28, Ohio.

Circle No. **37** *on Reply Card*



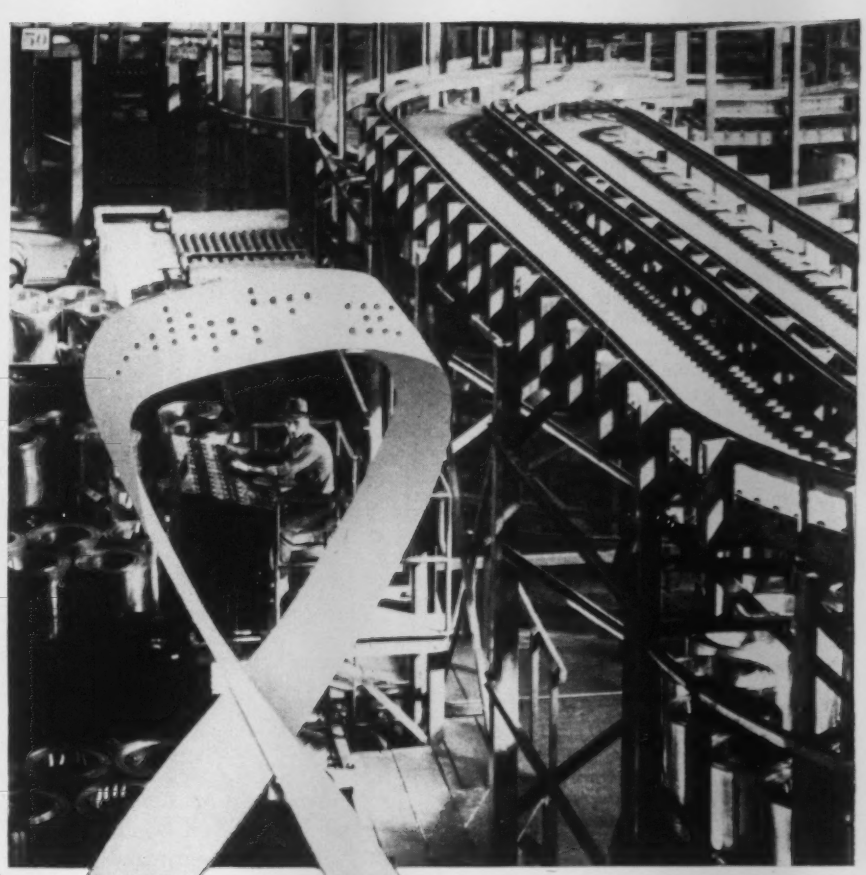
Air, Hydraulic Cylinder

A clamp type air or hydraulic cylinder is applicable to toggle operations, spring return motions, die set strippers, pilot operation of valves, opening of die sets, multiple holding and clamping operations, jigs and fixtures. Cylinder is of all steel construction except for bronze bearings and synthetic piston packing which gives operating range of −55 to 250° F. Universal mount will allow threaded nose, foot, front or rear flange mounting. If necessary, pivot, trunnion, clevis mounts can be supplied. Six standard styles available are (1) single acting, spring return (air or oil push), 1 or 2-in. stroke, (2) single acting, spring return (air or oil pull), 1-in. stroke, (3) double acting, 1 or 2-in. stroke, (4) single acting, spring return (push), air or oil solenoid operated, 1 or 2-in. stroke, (5) single acting, spring return (pull), air or oil solenoid operated, 1-in. stroke, and (6) double acting, air or oil solenoid operated, 1 or 2-in. stroke. Other strokes are available on special order. Cylinder measures 5 x 1½ x 1½-in. **Carter Controls, Inc.,** 2800 Bernice Rd., Lansing, Ill.

Circle No. **38** *on Reply Card*

Automatic Testing Controllers

A complete line of automatic testing controllers has been designed for use in conjunction with all standard testing machines, new or old. Six types of test are available in individual units or in one



Brass Coil Storage Conveyers. Flow of materials is controlled by the one operator at pulpit.

how Mathews Conveyer Systems have been helping to make *Automation* a reality

● Mathews Conveyers, equipped with such control devices as electric eye mechanisms, traffic control units, special brakes and stops, and automatic deflectors, have for several years been helping manufacturers to progress toward automation by handling materials to processing machines and away with a minimum of manual effort. In almost every industry, in plants throughout the United States and Canada, you'll find Mathews Conveyer Systems at work helping to make AUTOMATION a reality. Write for informtaion to the Mathews Field Office or Plant nearest you.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
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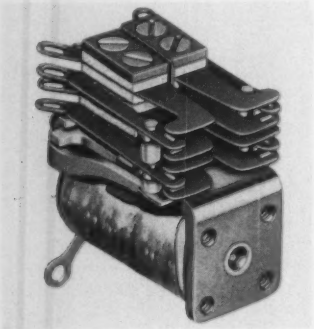
composite program controller (illustrated). Stress (load) cycling operation cycles any prescribed specimen between minimum and maximum loads and can be preset or readjusted between load limits at any time. Strain cycling controller automatically repeats strain applications between zero and the maximum strain range of the instrumentation. Both control points are independent of stress and elasticity and may be preset or changed during tests. Crosshead cycling unit regulates limits of testing machine crosshead travel during loading and unloading. Another function automatically conducts entire testing operation for any number of production tests with the same type of specimen. Once set for a given type specimen, machine will test tension, compression, or flexure in rapid succession on similar specimens without further manual adjustment. An automatic proof testing unit loads at fast speed until a control point is reached which switches to slower speed, and a third control point switches to automatic unload and readies machine for next test. Another controller determines the yield strength of a specimen in production testing by the extension under load method. Controller is used in conjunction with an extensometer in this operation. **Tinius Olsen Testing Machine Co.**, Easton Rd., Willow Grove, Pa.

Circle No. **39** *on Reply Card*

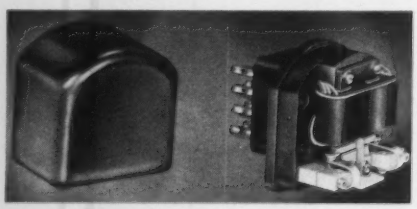
Miniature Telephone Type Relay

Tiny but efficient dc relay employs one air gap in its magnetic assembly and maintains armature rigidly in three major axes by means of a retaining spring. Elimination of hinge pin does away with friction. Welded crossbar contacts assure positive alignment of contacts. Weighing only 1.2 oz and measuring 0.94-cu in., relay comes in contact combinations up to 6-pole double-throw. It operates at 90 milliwatts or less, is 3 amp resistive and 1 amp inductive at 26½ v dc. Temperature ranges from −55° C to 85° C on standard coil, and to 125° C on Teflon coil. One million cycles is minimum life expectancy. Relay



can be open or hermetically enclosed, has nylon bobbin on which any high temperature insulation can be wound. Ceramic bumpers fasten to blades mechanically and eliminate failures due to use of cement. **Advance Electric & Relay Co.**, 2435 N. Naomi St., Burbank, Calif.

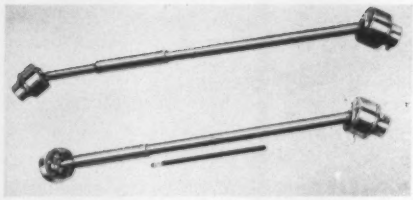
Circle No. **40** *on Reply Card*



High Speed Polar Relay

PTW polar relay is sensitive to high-speed pulse repeating and performs dependably when low current is transmitted over long lines. Spacing of contacts takes only a set-screw adjustment and no critical adjustments are necessary. Relay is suitable for teletypewriters, for line current direction indication and as differential relay in "Wheatstone Bridge" control. Measuring only 2 7/16 x 2¼ x 3 5/16-in., unit features a removable snap-on cover for visual inspection. **Automatic Electric Sales Corp.**, 1033 West Van Buren, Chicago 7, Ill.

Circle No. **41** *on Reply Card*



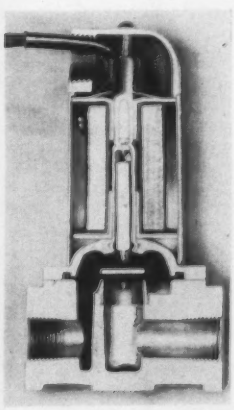
Lightweight Universal Joint

Rzeppa line of constant velocity joints has a new, miniature, lightweight model universal joint. Compact and rugged, new joint has been designed for uniform power flow, minimum weight and long life. Angularity is 0 to 40° depending on speed and torque. Shaft length is adjustable. **Joint Div., Gear Grinding Machine Co.**, 3901 Christopher, Detroit, Mich.

Circle No. **42** *on Reply Card*

"DO" Valves

A new line of diaphragm operated solenoid valves is designed for stand-by control of fluid flow and for automatic cycling operations on controlling machines. Valves will control air, water, oil, Freon refrigerants, fuel gases and sulphur dioxide gas. Operating on line pressures up to 150 psi, or with as little as ½-in. of water, valve's ideal cycling range is between 40 and 60 cycles per minute. Aluminum bodies for gas and air service, or brass bodies for oil and water service can be supplied. Low power consumption, noiseless operation, coil interchangeability, wide choice of control, maximum shut-off safety and ease of maintenance are featured. Stock coils are 7 w maximum for 115 and 230 v, 50 or 60 cycles. Valve's only two moving parts are a solenoid plunger and rubber diaphragm, while conventional valve guides, seat ring gas-



kets, pilot valve cages have been eliminated. Because rim of diaphragm serves as gasket, correct alignment of plunger with valve disc is assured. Diaphragm valve disc of synthetic rubber is designed for use with elements measuring up to 180° F. Shading rings in plunger and tube assembly prevent ac hum and chatter. "DO" valves may be activated by thermostats, timers, pressure or limit switches, and manual devices. Valve will close automatically if current fails and can be serviced without removal from line of operations. Six pipe sizes available are ⅜, ½, ¾, 1, 1¼ and 1½-in. **Eclipse Fuel Engineering Co.,** 1011 Buchanan St., Rockford, Ill.

Circle No. **43** *on Reply Card*

Alphabet Template

New template for industrial designers and drafters consists of alphabet and numerals in block letters ⅜-in. high. For free hand letterers three guide slots are included in ⅛, ¼, and 3/16-in. heights. Rounded corners give radii of ¼, ½, ¾, and 1-in. Entire template is molded of polystyrene and colored for easy visibility. Overall size is 6¾ x 3¾-in. **Rapidesign, Inc.,** Box 592, Glendale, Calif.

Circle No. **44** *on Reply Card*

Liquid or Slurry Regulator

Regulator with capacity of 275 gpm has been added to manufacturer's SA series of regulators to control flow rates of liquids and light slurries. New model's capacity ranges from 50 to 275 gpm, but entire, self-contained unit measures only 13-in. in diameter and 30-in. high. Pipe connections are 4-in. Smallest model in series has capacity of 2 to 10 gpm, measures 3½-in. in diameter and 9-in. high, and has ¾-in. pipe connections. All regulators in the series

PLANET ROBOT PULL-OUT CAR

ROBOT CAR CONTROL PANEL ▶

to load and unload furnaces... automatically...

Just Press A Button

This PLANET robot car, specially designed for heat treating operations at a large automobile plant, is completely automatic and entirely self-propelled. It loads and unloads trays of forgings weighing up to 600 lbs. from furnaces at *either side,* permitting a compact, space-saving installation.

Here's automation in action . . .

Trays are withdrawn from a right hand furnace and discharged into furnaces on the left. The entire cycle is handled by pushing one button.

If you have a materials handling problem, it will pay you to "Plan with Planet". Experienced Planet engineers design and install specially engineered systems complete from the preliminary survey and specifications to installation and testing.

Write today . . . for information on applying automation to your operations.

PLANET CORPORATION

1810 SUNSET AVENUE
LANSING, MICHIGAN

- CONVEYORS
- ENGINEERED SYSTEMS
- FOUNDRY EQUIPMENT
- AUTOMATION
- STEEL FABRICATION

Let's talk sense about

FOR AUTOMATION OR MODERNIZATION . . . YOU NEED MOLDING MACHINES DESIGNED TO HANDLE VARYING PRODUCTION REQUIREMENTS

THE problem of achieving greater economy and efficiency in the face of rising costs must be met by every foundry according to its specific requirements. For some, the answer lies in *automation* . . . the use of fully automatic machinery and systems which can operate with minimum supervision and human effort. For others, whose plant size and production volume do not permit the use of complex coördinated equipment, the solution is *modernization* . . . the replacement of obsolete models with improved machines engineered for efficient low-cost operation.

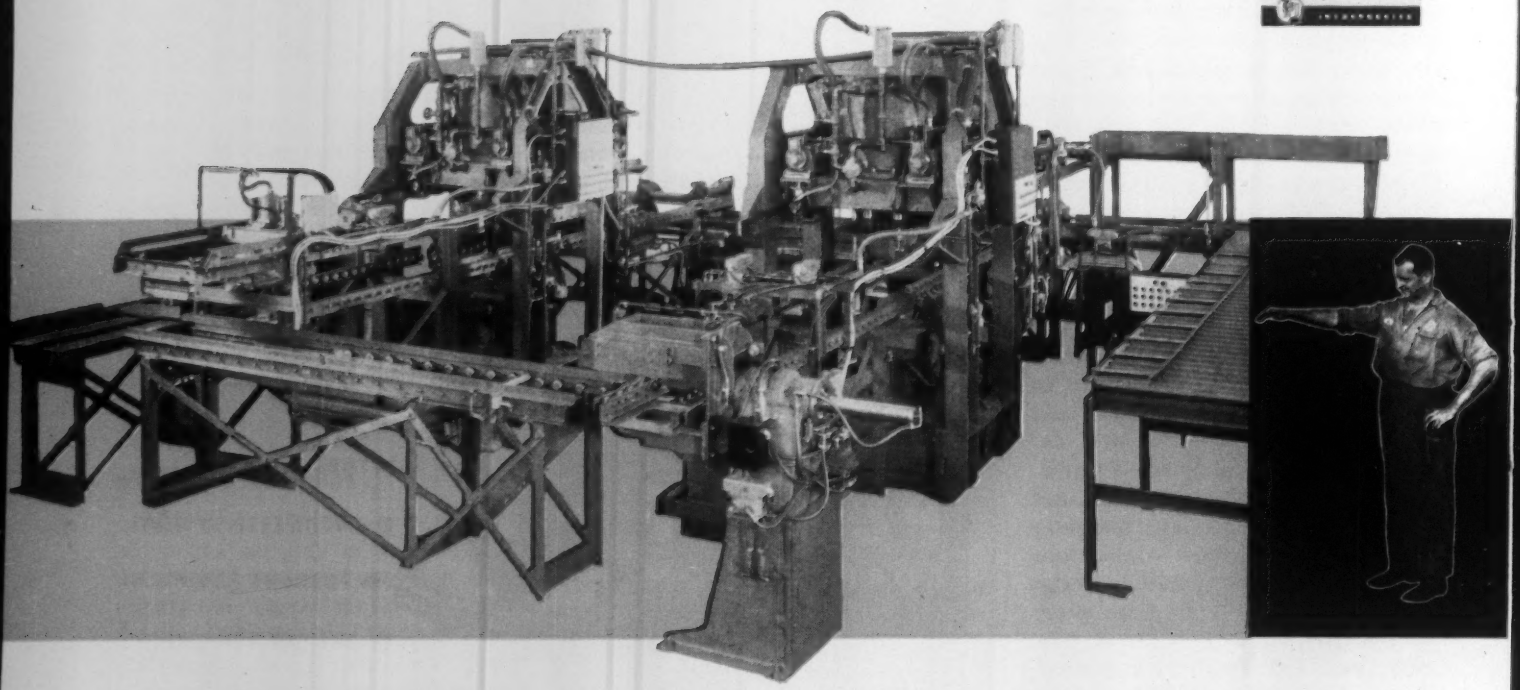
Whether your foundry is ready for automation or a modernization of its existing facilities, SPO builds the molding machines you need for higher production at lower cost.

. . . IF YOU'RE READY FOR COMPLETELY AUTOMATIC MOLDING

As the first practical automatic molding unit, the SPOMATIC has made complete automation possible in the foundry. This unit provides the most efficient, economical and high-speed method of "hands-off" production molding available today. Once a SPOMATIC is started, all operations are fully automatic, mechanical and continuous.

All SPOMATIC installations are engineered to individual production requirements. Capacities of the various integral components can be widely varied. In addition, each machine's versatility is controlled by the flask size specified and the variety of molds possible within that size.

SPOMATIC is the trend-setting molding machine designed to bring automation to foundry operations . . . to make the "foundry of the future" a reality today! Write for Bulletin "MM" for additional details.



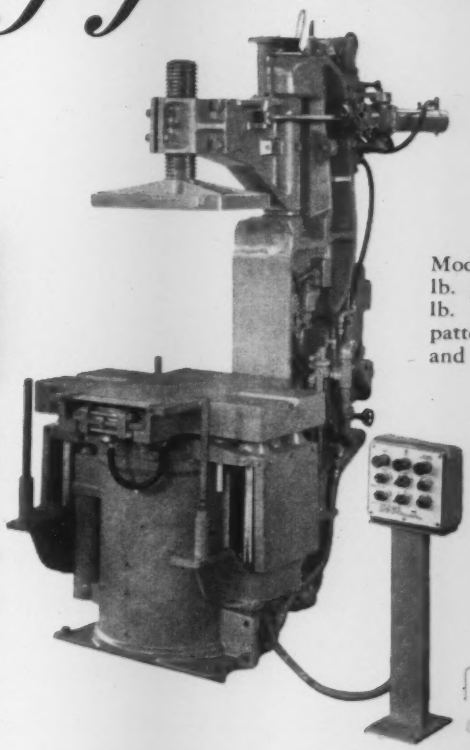
From the smallest to the largest . . . there's a SPO for every molding job

the changing foundry

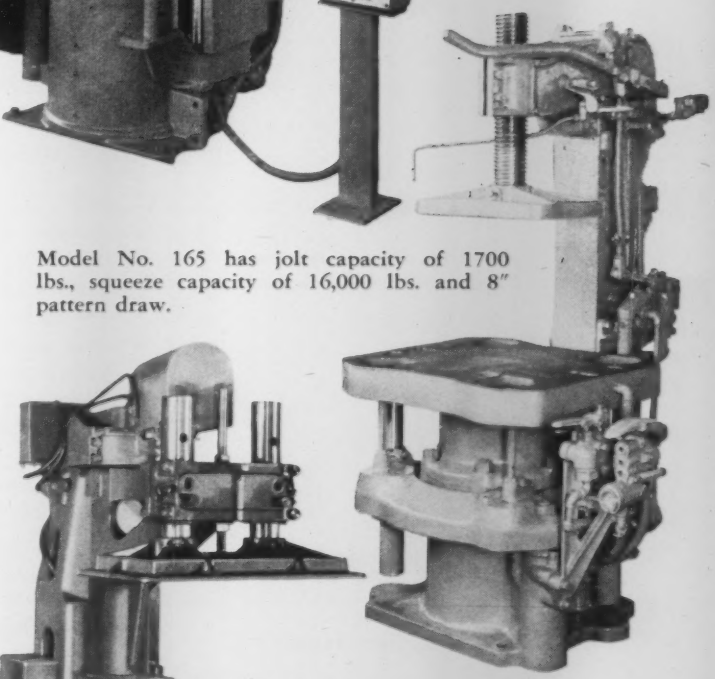
. . . IF YOU'RE GOING TO IMPROVE EXISTING FACILITIES

SPO produces a complete line of molding machines to meet every foundry's needs . . . both for jobbing and mass-production operations. Ranging from small manually-operated units to semi-automatic pushbutton giants, SPO machines are engineered for safe, economical, high speed operation and the production of uniform standard molds. Most of these versatile machines feature the patented "inverted jolt" mechanism, which assures maximum efficiency and service life with minimum maintenance. All SPO units are shipped complete with necessary valves, controls and lubrication fittings. Only an air line need be attached for operation. To meet individual needs, a variety of accessory items also can be supplied for many types of SPO machines.

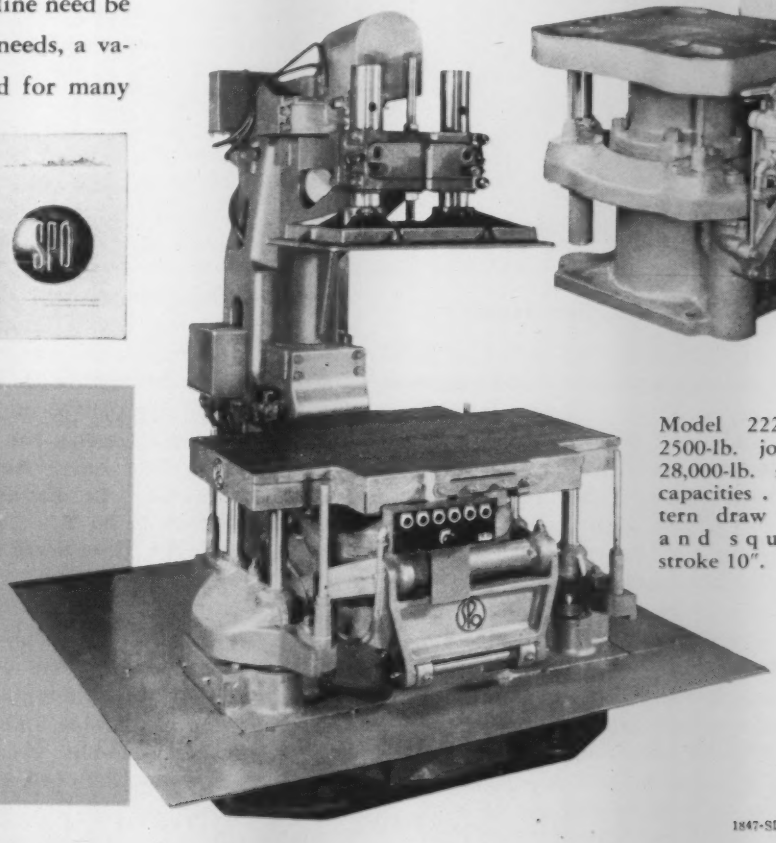
The SPO molding machines illustrated on this page are only a few examples of types and sizes available today. Write for new 8-page bulletin for additional details.



Model 2160-C has 1500-lb. jolt capacity, 16,000-lb. squeeze, adjustable pattern draw (6 to 10") and 12" squeeze stroke.



Model No. 165 has jolt capacity of 1700 lbs., squeeze capacity of 16,000 lbs. and 8" pattern draw.



Model 2222 has 2500-lb. jolt and 28,000-lb. squeeze capacities . . . pattern draw is 12" and squeeze stroke 10".

WORLD'S LARGEST SUPPLIERS SPO OF MOLDING MACHINES

1847-SI

SPO INCORPORATED 6570 GRAND DIVISION AVE. • CLEVELAND 25, OHIO

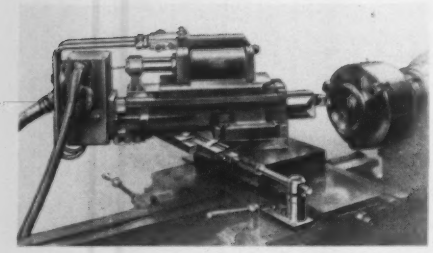
can handle variations up to 125 psi in inlet-to-outlet pressures with accuracy that will not vary over 3 per cent. Self-cleaning, simple, and with no time lag, regulators can handle light slurries, suspensions, hot tar solutions, etc. **W. A. Kates Co.,** 430 Waukegan Rd., Deerfield, Ill.

Circle No. **45** *on Reply Card*

Lead Screw Tapping Head

Auto-Tap can be attached to quill of any drill press and adapted for semi or fully automatic precision lead screw tapping. Unskilled help can produce precision threads with no misalignment in thread caused by pressure exerted by operator. A rapidly interchangeable lead screw, a cone clutch reversing mechanism, and positive depth control produce perfect threads even in blind or recessed holes. Tap breakage and work spoilage are reduced because machine is actuated before engaging work and lead screw guides tap accurately in and out of work. Tap withdraws quickly and floating workpiece is positioned rapidly. Two models are available, one for tapping 0 to 5/16-in. threads, and one for 10/32 to ¾-in. threads. **Div. 228, Automatic Methods, Inc.,** 965 W. Grand St., Elizabeth, N. J.

Circle No. **46** *on Reply Card*



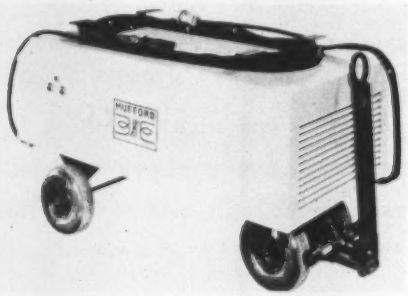
Lathe Copying Attachment

A lathe duplicating attachment can be added to any standard lathe of 16 to 24-in. swing for precision duplication of cams, spindles, axles, shafts, valve stems and piston rods. When template has been made, tracer follower will guide lathe cutting tool for inside and outside longitudinal turning of shoulders, chamfers, compound radii, thread runout grooves and other intricate shapes. Tracer follower accuracy is 0.0002-in. and pressure is 3½ oz. Self-contained hydraulic unit consisting of pump and motor is placed at rear of lathe and operating pressure is a low 140 to 210 lb. Operator can turn his own round templates on the job and templates need not be of hardened steel. Round templates may be used for most longitudinal turning operations, eliminating need for more costly flat templates. For facing and other lateral operations, a flat template holding attachment is available. One model can be used with both flat and round templates, and an alternate model is made for use with flat template only. **Acc-U-Mat Machine Co.,** 40 Exchange Place, New York 5, N. Y.

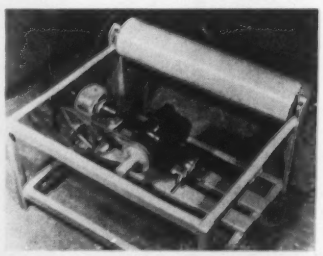
Circle No. **47** *on Reply Card*

Portable Power Supply

A new heavy-duty series of ac to dc regulated power supplies is available in both portable and stationary models. Models are designed for use on 220/440 v, 3-phase, 60 cycle ac input, and are available in any desired output voltages and current capacities. Output voltage remains within plus or minus 1 per cent, no load to full load, with line fluctuations up to plus or minus 10 per cent. Under extreme load and variations recovery time is less than 0.2 second. AC ripple is removed to less than 1 per cent rms by a filter section made up of choke and condenser combination. Magnetic amplifier voltage regulators are insensitive to vibrational damage or burn-out failures. Machines employ dry type full wave selenium rectifiers and built-in cooling fans. New power supplies will serve dc functions necessary for production line testing, pre-flight checkout of electronic equipment, laboratory testing, engine starting, anodizing and electroplating. **Electronics Div., Hufford Machine Works Inc.,** 2201 Carmelina Ave., Los Angeles 64, Calif.



Circle No. **48** *on Reply Card*



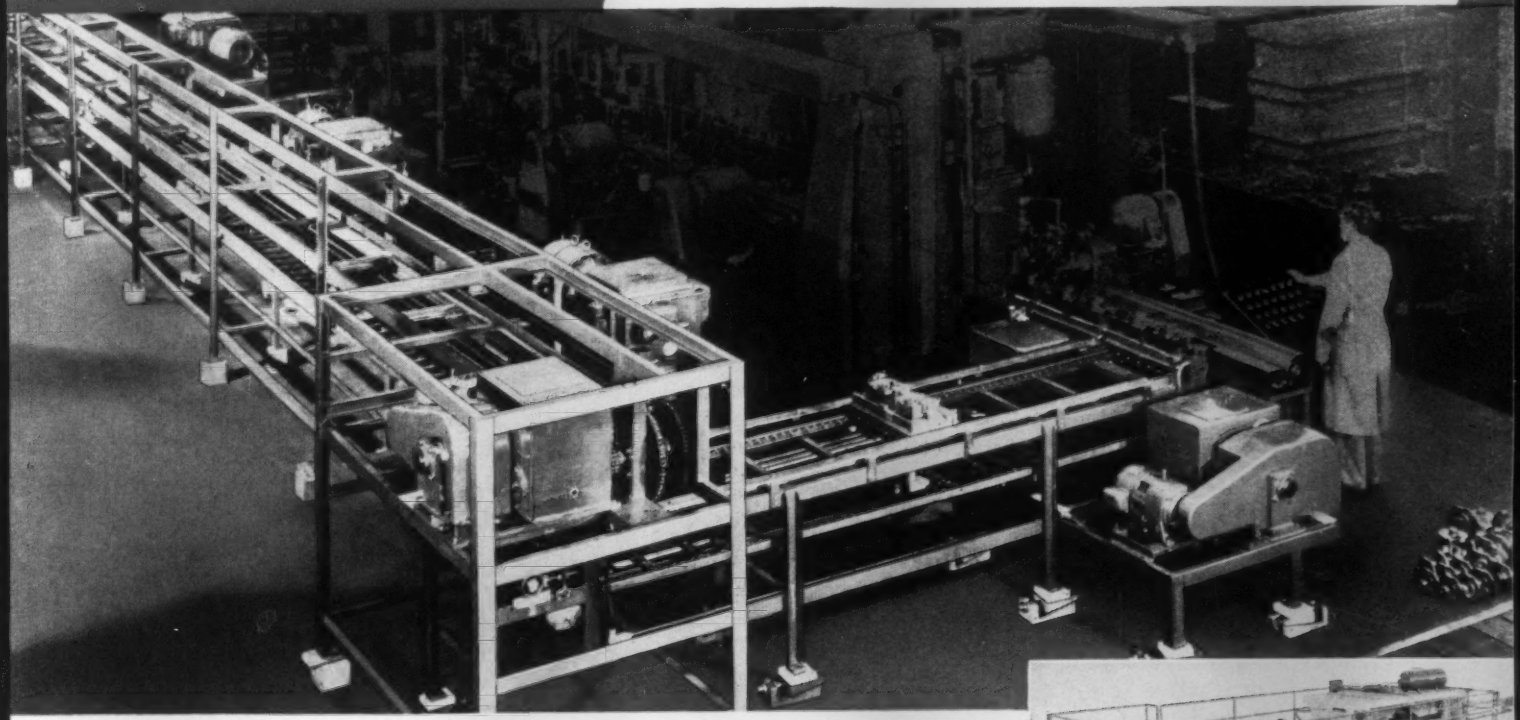
Conveyor Power Unit

"Add-A-Drive" power unit can be added to gravity roller conveyor to convert to powered belt when material requires traction for moving in horizontal, inclined or declined planes. Unit is self-contained and runs by 1/3, ½ or ¾ hp motor suitable for 110 v, 60 cycle, single phase, or 220 or 440 v, 60 cycle, three phase current. Belt widths to fit unit are 8, 10, 12, 16, 24 and 30-in. **Sage Equipment Co.,** 30 Essex St., Buffalo 13, N. Y.

Circle No. **49** *on Reply Card*

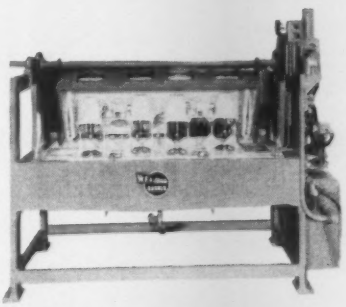
Now Available

A Special AUTOMATION EQUIPMENT Designing and Building Service



▲ Many progress-thru type machine tools employ special conveyors to return the work-holding fixtures to the loading end of the machine, as shown above. Barnes conveyors are designed to do this work automatically, in cycle with the machine, to greatly reduce work-handling costs.

▲ Another Barnes unit designed to speed work-handling is this special two-carriage automatic loader and unloader for handling heavy railroad axles before and after machining. Smooth, accurate traversing of the carriages is accomplished with a special electrical slow-down circuit.



▲ This special semi-automatic testing machine was developed by Barnes to test for leaks in automotive power steering castings. It handles four workpieces per cycle. Except for loading and unloading, all operations are performed automatically.

COMPLETE facilities are now provided by the Process Equipment Division of the W. F. & John Barnes Company for the designing and building of standard and special automation equipment. Widely experienced in this specialized field, Barnes have developed many units, both large and small, which are now successfully and profitably cutting work-handling costs and increasing production output in hundreds of industrial plants. The three units illustrated are typical of the broad range and variety of thousands of methods and processes developed by the Barnes' Process Equipment Division.

Here at Barnes, you'll find the varied engineering and creative skills, plus over 75 years of machine building background, to help you solve many troublesome production problems. And because all planning, engineering, and manufacturing efforts are closely coordinated, you have available a complete *Automation Equipment Service* from one convenient source.

ASK FOR AN ANALYSIS OF YOUR WORK-HANDLING METHODS

Find out how these unique creative and specialized resources can help you cut costs. Your problem will be given expert and individual attention.

GET THIS *Free* BOOKLET

Write today for your copy of "Co-ordinated Creative Engineering and Manufacturing" — a 32-page booklet crammed with cost-cutting *Automation Equipment* ideas.

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PROCESS EQUIPMENT DIVISION

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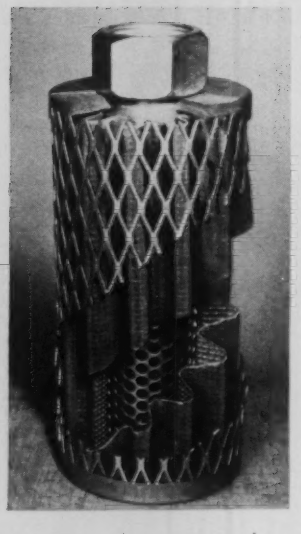
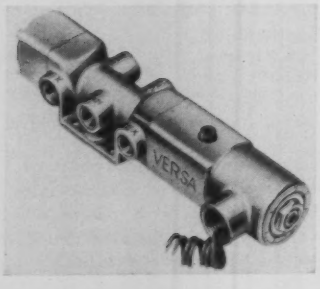
BUILDERS OF BETTER MACHINES AND EQUIPMENT SINCE 1872



Hydraulic Fluid Filter

Sump (illustrated in cutaway photo) and line type filters for filtration of nonflammable hydraulic fluids maintain a balance between maximum active filtering area and storage capacity for filtered particles to permit longer periods of productive operation. Capacities of sump or line installations range from 5 to 100 gpm, and greater capacities are possible with multiple installations. Units are available in monel meshes ranging from coarse 30 to fine 200 according to size particles to be handled. Line model operates in any position, may be serviced without disturbing pipe connections. All models can be disassembled, cleaned and reassembled with ease. **Marvel Engineering Co.**, 625 W. Jackson Blvd., Chicago 6, Ill.

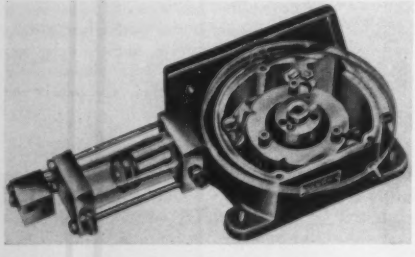
Circle No. **50** *on Reply Card*



Solenoid Valves

Entire line of 2, 3, and 4-way valves in ⅛, ¼, ⅜ and ½-NPT sizes is operated electrically by a new solenoid actuating device. Small solenoid controls a pilot cylinder in valve, providing fast, positive force for shifting valve spool. Solenoid cylinder actuation is more dependable, safe, fast and light, and less expensive than direct solenoid actuation. Valves may be repositioned by spring return, or by hand, cam, pilot or foot actuating devices, or by a second solenoid. Pilot cylinder requires no additional line when used for pressures up to 150 psi because valves are drilled internally to supply main line air or fluids. In 150-500 psi, an auxiliary line of 35-150 psi is required. All internal parts of valves are interchangeable. A screw driver services or disassembles valves in the field without disturbing pipe connections, facilitating rapid alteration from one valve type or actuation system to another. Seal rings are airtight and impossible to cut because of "anti-extrusion" arrangement of kinetic "O" Ring Seals. **Versa Products Co., Inc.**, 249 Scholes St., Brooklyn, N. Y.

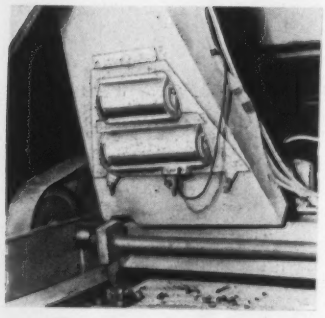
Circle No. **51** *on Reply Card*



Dial Feed Indexing Table

New indexing table is available in two models, 725-FA without control valves, and 725-FB equipped for fully automatic operation. Dial feed table can be mounted either vertically or horizontally, has 7¼-in. diam top plate, and features a positive locking device. Compressed air at top center of table permits air clamps, collets or chucks to be operated from outside source while table revolves. Standard 4, 6, 8, 12 and 24 set indexing positions are available and accuracy is guaranteed within plus or minus 0.002 at periphery of top plate. Regardless of index set, piston always returns to rear of cylinder and insures instant response and conservation of high pressure air. **A. K. Allen Co.**, 57 Meserole Ave., Brooklyn 22, N. Y.

Circle No. **52** *on Reply Card*



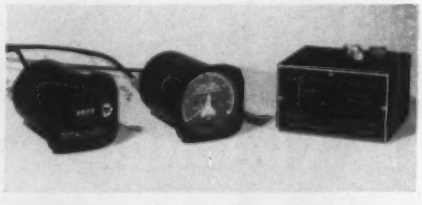
Magnetic Separator Alarm

A completely automatic alarm system for use with magnetic separators contains a sensitive ferrometer which constantly measures the quantity of tramp iron and ferrous particles as it accumulates on the magnet's surface. Meter reacts on a circuit to trip any standard type of alarm such as lights, bells, buzzers, as soon as a predetermined accumulation is reached. Unit can be located at the machine or in a remote office. Protection and peak efficiency of the separator are insured because alarm alerts maintenance men automatically, thereby eliminating guesswork in inspection. Small current required to operate alarm will not affect the magnetic field of the separators. **Eriez Mfg. Co.**, 1945 Grove Dr., Erie, Pa.

Circle No. **53** *on Reply Card*

Airborne Flow Metering System

An airborne flow meter system is composed of a flow sensing element (not illustrated), a rate indicator and a totalizing unit. Because magnetic circuits are used in place of electronic tubes, indicator and totalizer fit into two standard 3½-in. cylindrical housings for installation on instrument panel. Sensing element is available with capacity as low as 0.1 gpm and as high as 3,000 gpm. Indicator electronically converts ac signal from sensing element into a proportional dc output which is measured and indicated as rate of flow. Indicator may have front calibration adjustments and needle-type point-



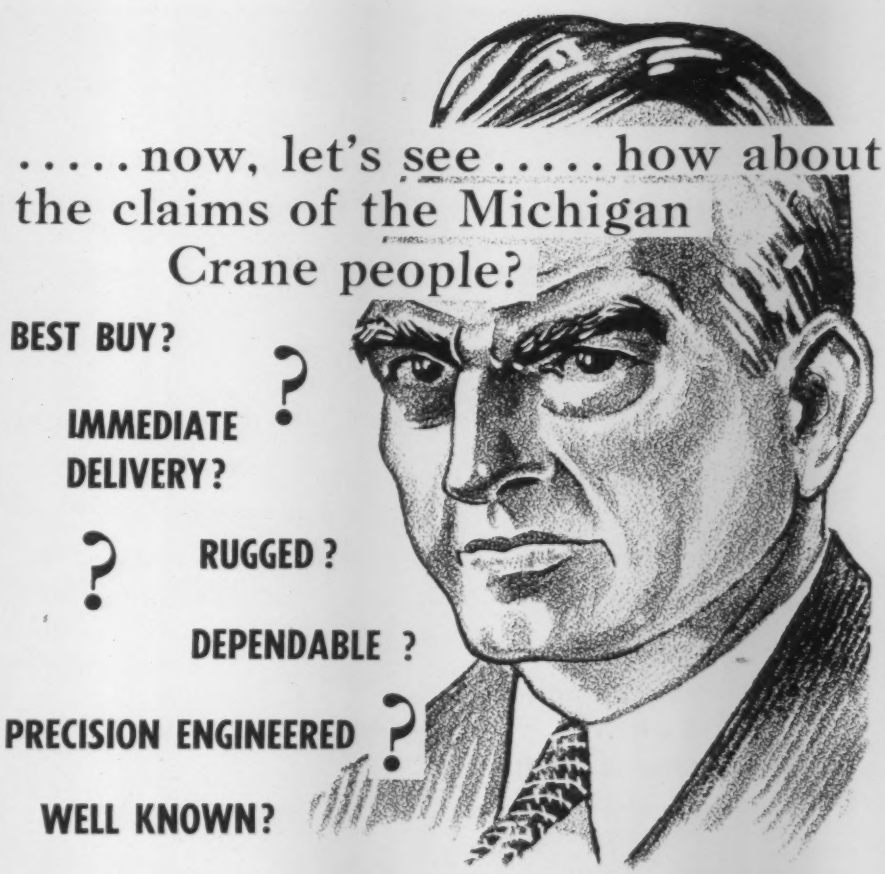
er for highly accurate reading, or solid dial face and broad pointer for rapid reading. Totalizer registers total number of output pulses produced by sensing element, divides by a factor of 32 and multiplies by a constant factor to obtain volume of flow. Only four tubes are used in each instrument. Low power consumption, totalling 17½ w in indicator and totalizer combined, minimizes drain on already overloaded aircraft electrical systems, and prevents excessive heat within instrument cases. Internal temperature compensation in the rate unit keeps thermal drift within ½-per cent at ambient temperatures in excess of 110° F. Systems operate from either 400 cycle 115 v ac, or 24 v dc power supplies. Frequency standard can be used for ground checking. **Potter Aeronautical Co.,** 87 Academy St., Newark 2, N. J.

Circle No. **54** *on Reply Card*

Circuit Breaking Device

A low cost, relatively large service switch, No. 2068, is available for circuit breaking in small industrial operations. Three-wire circuits are fed in parallel from 200 amp mains. One circuit controls the lower bus which accommodates either eight single-pole circuit breakers or four 2-pole simultaneous trip circuit breakers. New "E" slots in enclosure bus bar permit device to accommodate ten lighting breakers in the lower bus. Enclosure is combination flush-surface. Removable solderless main lugs and straight through wiring in the ground bus are featured. A similar model, No. 3068, is available with 300 amp mains. **Federal Electric Products Co.,** 50 Paris St., Newark, N. J.

Circle No. **55** *on Reply Card*



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Call in

MICHIGAN CRANE

MICHIGAN CRANE is know from coast to coast for its rugged dependability: owners will tell you that. They will tell you, too, that "immediate delivery" meant exactly that; they will tell you that they were satisfied on every count. Why? Because every MICHIGAN CRANE combines precision engineering and manufacturing with other important features—such as anti-friction bearings at all moving points on bridge and trolley; optional fluid couplings; easily replaceable standard mill parts throughout. Our staff of materials handling experts will be glad to consult with you on any automation problem involving cranes. No obligation, of course. Meanwhile, write for our new general Crane bulletin.

MICHIGAN CRANE

AND CONVEYOR CO.

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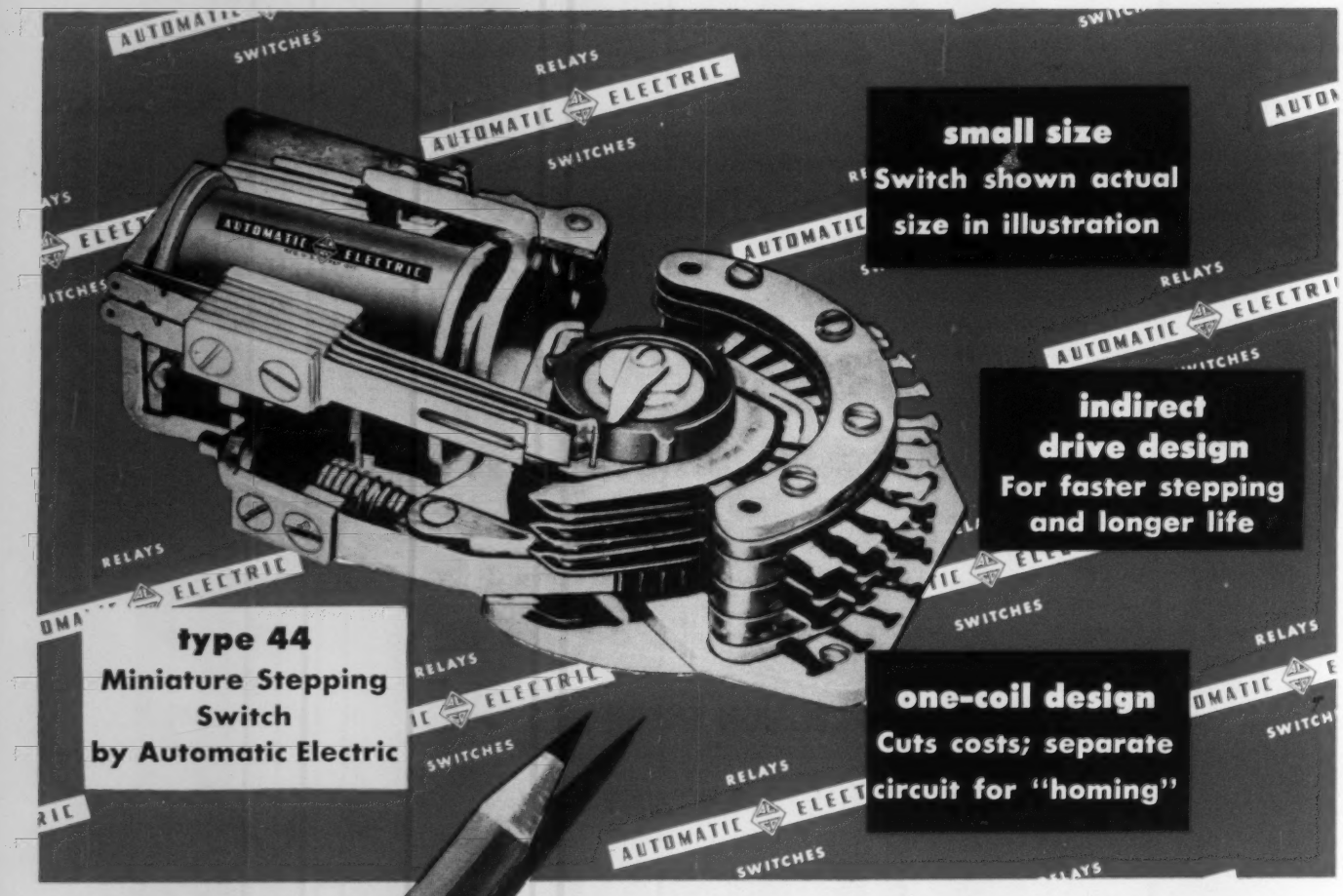
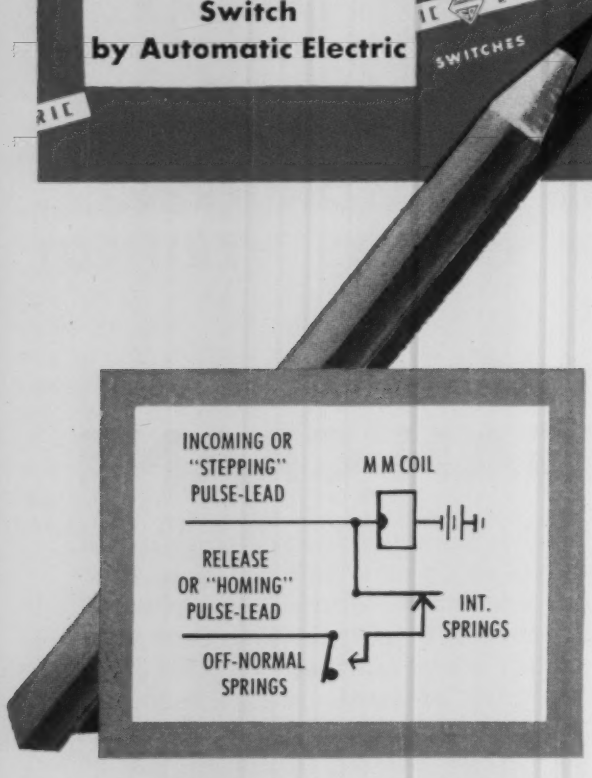




How separate "homing" circuit is provided with one-coil operation

Interrupter contact springs open coil circuit near the end of each armature operation—causing switch to step by self-interruption, or by "door buzzer" action.

"Off-normal" contact springs close "homing" circuit on first step of wipers off home position and remain closed until home position is again reached. Thus, after the first step, a "homing" circuit is prepared, and the switch may be "homed" by simply energizing this circuit.

How to make a good product better...without increasing costs

Design engineers everywhere are choosing Automatic Electric's Type 44 Miniature Stepping Switch to insure long service life—often *reducing* costs as they do so! In countless applications, this sturdy switch has operated for more than 200 million operations, with little or no adjustment. The one-coil design eliminates a separate release coil—a saving passed on to the user.

And there are other reasons for such widespread approval: weight and space are saved; indirect drive design give smooth stepping and because there's no wiper "double loading" there's no "galloping"; the unique driving mechanism permits extremely high operating speeds.

Investigate Automatic Electric's Type 44 Switch for your control applications. Here's the first compact, lightweight switch to provide 10-, 20- or 30-point operations. Designed for any dc voltage up to 110, or, with an associated rectifier, for 115 volts 60 cycle ac. The Type 45 Stepping Switch is adaptable to 25-point operation (plus home) using wiper levels singly, or to 50-point operation using wiper levels in "staggered" pairs. For more details on Automatic Electric stepping switches, write for helpful engineering specifications to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

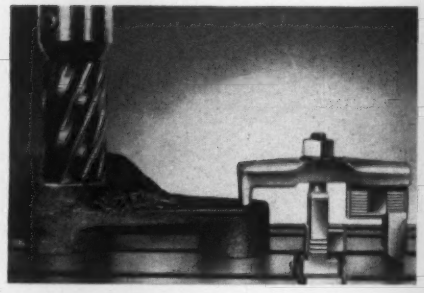
RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

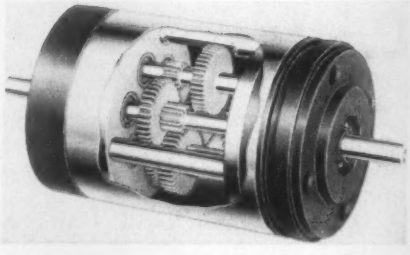
Write for helpful circular A1698-D



Adjustable Clamp

A new self-contained clamp eliminates tool room "bug-a-boo" of special blocking, shimming, searching for correct length bolts for each new set-up. Clamp rest and tee bolt utilize a serrated feature which permits rapid adjustment. Adaptors for vertical angle plate clamping are available. Clamp body is forged, heat treated for maximum toughness. A wide range of sizes is offered to accommodate every tool room clamping problem. Adjustability saves in bolt requirements and eliminates stripping of bolts. **Dept. 49, Hi-Lo Mfg. Co.,** 18525 Weaver Ave., Detroit 28, Mich.

Circle No. **56** *on Reply Card*

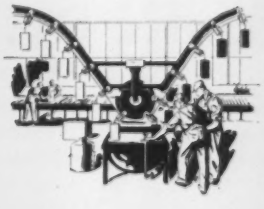


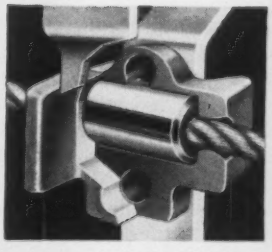
Miniature Speed Reducer

Speed reducer is made in two sizes for use with electronic controls, actuators and servos. Model 1062 measures 1.062-in. in diameter, is designed for output torque loads up to 25-in.-oz. Model 1687 is 1.687-in. in diameter and is rated at 100-in.-oz. maximum. Units are equipped with ball bearings but sleeve bearings for gear clusters are available when optimum precision is not required. Cap assemblies of anodized aluminum, housing and bearing plates of corrosion resistant steel, gears of stainless steel or aluminum bronze are featured. Slip clutches and mounting hangers can be supplied. **Bowmar Instrument Corp.,** 2415 Pennsylvania St., Fort Wayne, Ind.

Circle No. **57** *on Reply Card*

"Bush-Lock" by Buschman





Patented BUSH-LOCK design permits fast, easy installation, revision and maintenance of systems.

Here is a tried, proven, accepted conveyor whose patented design gives 30 times greater cable life . . . enables user to stock standard lengths of cable for fast easy maintenance, revision or expansion of installations . . . facilitates lubrication to protect against acid, moisture and other deteriorating factors . . . provides for increased range of applications.

BUSH-LOCK Cable Conveyors feature cylindrical bushings immovably locked to cable on accurate centers by high pressure swaging. Two halves of an adaptor block, to which trolleys and load-bearing hook attach, are bolted around the bushing. Rotary floating action of bushing in wide radius adaptor block assures constant alignment of trolley, eliminates binding of cable at flexure points.

New BUSH-LOCK Cable Conveyor is available in ¼" and ⅜" sizes for transporting parts through cleaning, drying, painting and progressive assembly operations or as overhead storage banks. Because short radius horizontal and vertical curves, more compact layout is possible, conserving valuable space.

Both ¼" and ⅜" BUSH-LOCK Cable Conveyors will operate on existing Buschman Snub-Lock design systems.

C-131-EWB

PRODUCE MORE ... FOR LESS on Buschman Conveyors

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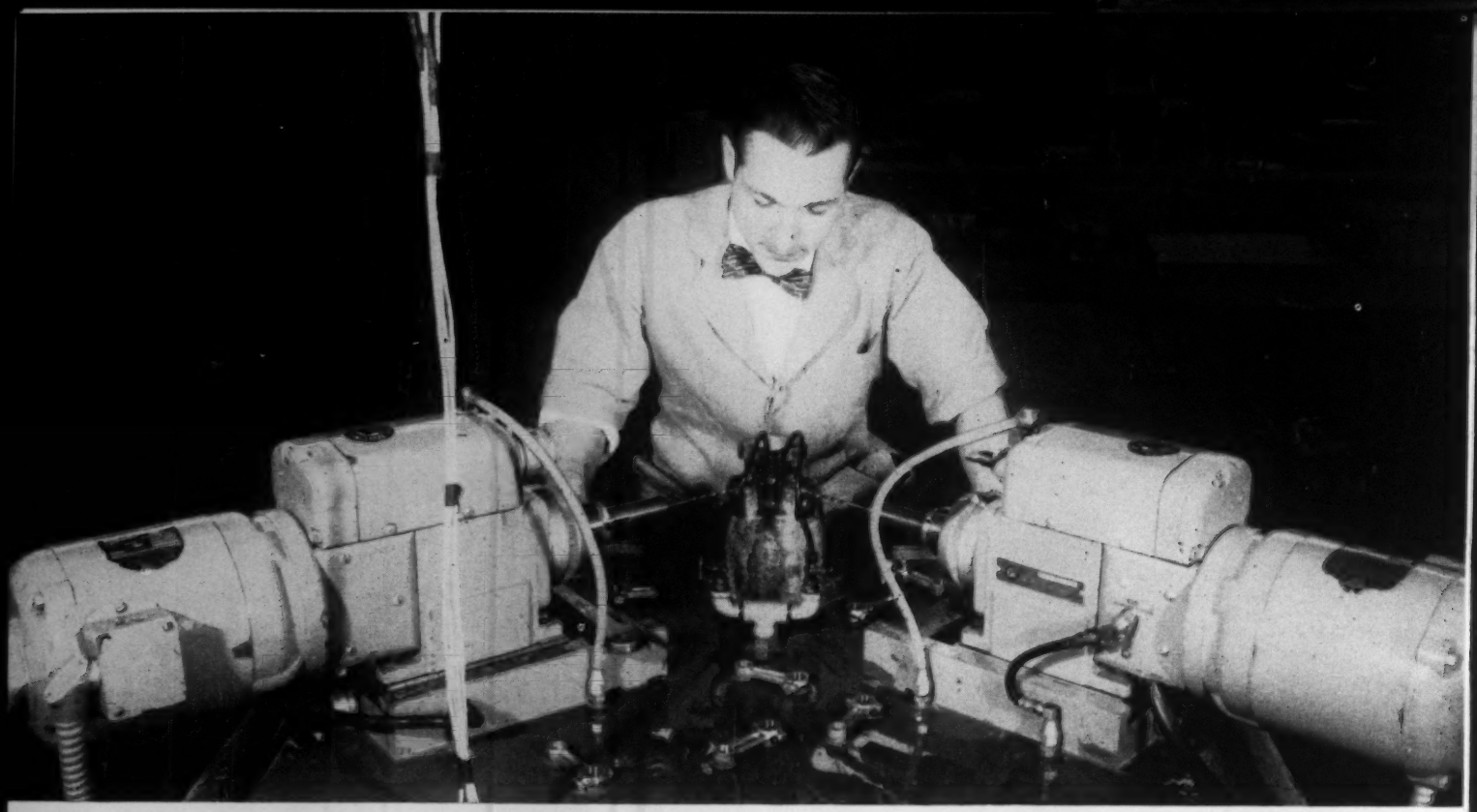
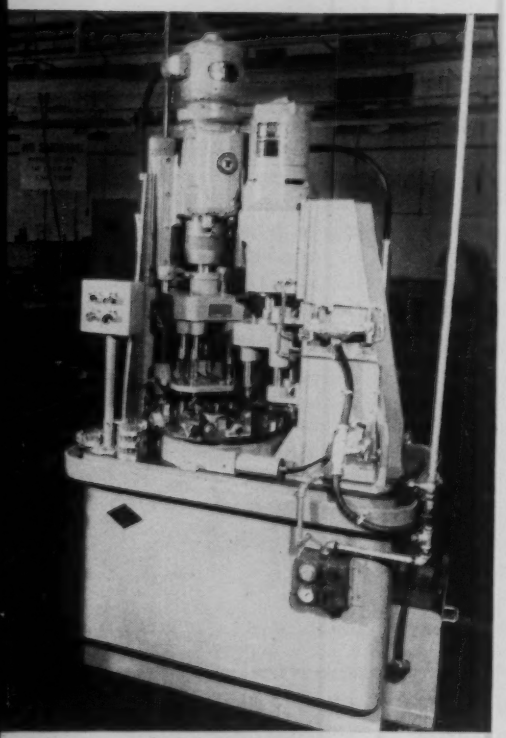


How McCulloch Motors Corporation Tooled for MAXIMUM PRODUCTION at MINIMUM COST Through Better Methods...Utilizing Rockwell Air-Hydraulic Drill Units



MOUNTED AND ELECTRICALLY INTERLOCKED to provide a one, two operation, this Rockwell Drill Unit drills, reams two holes in cooling fans (see A and B in Figure 1) for McCulloch Saw Motors.

Techniques to hold costs down while improving quality in the manufacture of complex precision products have been reduced to a smooth flowing science by McCulloch Motors Corporation in Los Angeles.

By combining the principles of Automation with imaginative production planning, McCulloch has not only enjoyed meteoric growth, but is widely regarded as one of the most efficient manufacturing facilities in the nation. Production of the famous McCulloch Chain Saw is an outstanding example of the use of better methods made possible, in part, by developments in high-speed, automatic equipment, such as Rockwell Air-Hydraulic Drill Units* for close tolerance machining.

DRILL UNITS CUT COST THROUGHOUT

In the manufacture of power driven saws, cost reduction is effectively demonstrated by McCulloch's use of Rockwell Drill Units in virtually every segment of applicable tooling and machining. Drilling and boring operations on vital precision motor parts are performed automatically, with great rapidity, to tolerances of ±.0005". The low-priced Rockwell Drill Units are mounted in multiple sequence machines, specially designed to coordinate the flow of production.

The Rockwell Drill Units approach, machine to pre-set depth, then rapid retract, with non-productive time and motion reduced to a minimum of mere fractions of a second per cycle. Each machine operation is made to exacting limits, practically eliminating rejects. According to McCulloch production management, the Rockwell Drill Units provide great versatility, plus effective methods in achieving lowest possible cost-per-unit.

NEW METHOD BASIS FOR AUTOMATION

The Rockwell Air-Hydraulic Drill Unit itself is actually a new and somewhat revolutionary methods concept—the basic vehicle to *automation* in drilling, tapping, counterboring, and kindred operations. It is a completely self-contained, sealed production tool developed to provide maximum accuracy and cost efficiency in either high speed manufacturing, or slower, more specialized production. The Rockwell Drill Unit provides, for the first time, multi-

(Advertisement)

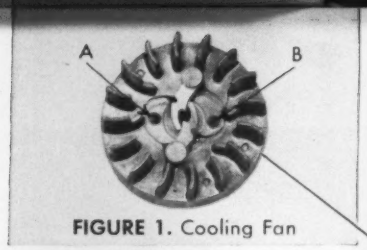


FIGURE 1. Cooling Fan

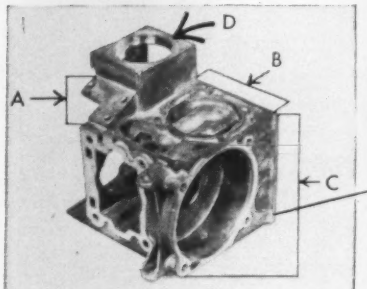
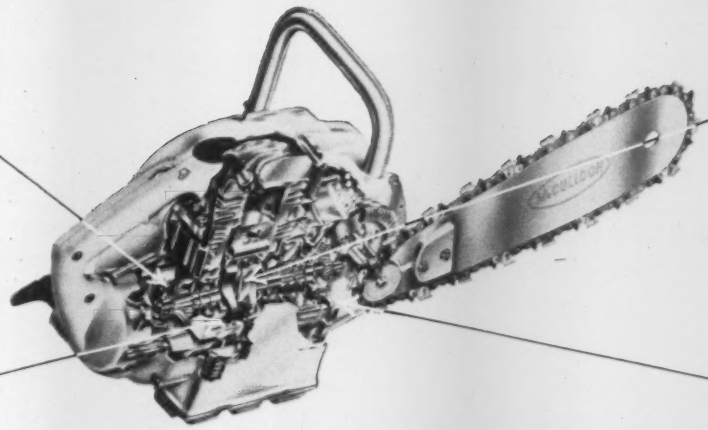


FIGURE 2. Crank Case



INSET PHOTOS indicate vital parts of the McCulloch Power Saw on which Rockwell Drill Units perform 44 machining operations. Better methods, utilizing machines like Rockwell Drill Units, enable McCulloch Motors to mass-produce precision products at competitive prices.

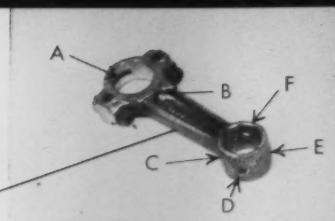


FIGURE 3. Connecting Rod

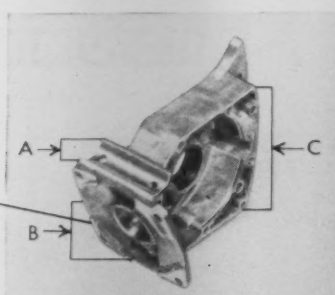


FIGURE 4. Gear Case

purpose adaptability in a compact, automatic and remotely controlled, precision power package. One operator controls all motion, and an entire size range of components can be handled without changeovers.

The plant air system provides the power for the positive hydraulically controlled motion, and three infinitely variable adjustments control length of approach, feed, and depth. No cams are used in the mechanism, and adjustments can be made while the unit is in operation. With only three basic moving parts, maintenance is negligible.

The Rockwell Drill Unit operates in any position, either singly, or in multiples, electrically interlocked with other units or mechanisms, and can be operated by unskilled personnel with minimum training.

SAVINGS PROVED IN USE

Here are a few examples of the way in which the Rockwell Drill Unit is providing manufacturers with better production at lower cost:

Radio Receptor Company saved $8,000 in first cost (the nearest machine in price to do the job cost $10,000.00), cut rejects to almost zero, while cutting cost per part by 40%.

Portable Electric Tools, Inc. report that "Rockwell Drill Units reduced production costs at least 25% on a job with tolerances of plus .0005" and minus .0001"."

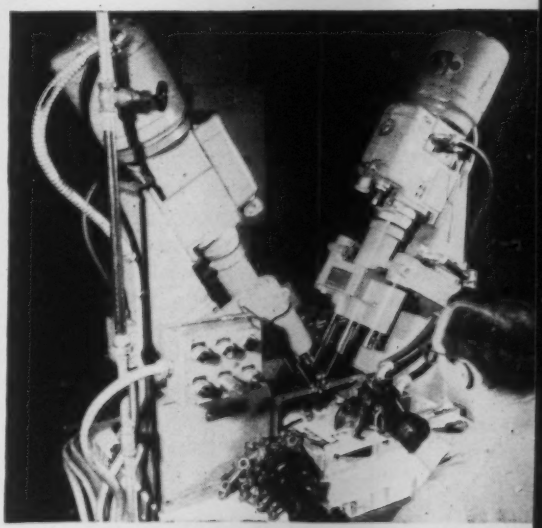
A. B. Dick Company's Rockwell Drill Units cut the time of machining a part from 25 minutes to 2 minutes.

Felt & Tarrant Manufacturing Company reduced cost of 15 operations by 10%, using Rockwell Drill Units on parts smaller than 3/16" diameter to tolerances of .0005".

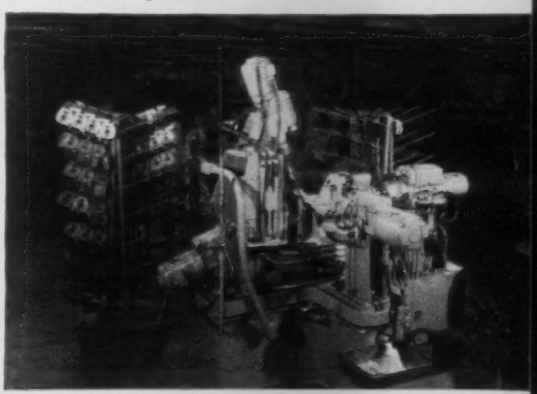
The Bossert Division of Rockwell Spring and Axle Company reduced cost of centering and chamfering differential spiders from $.0278 to $.0185 per unit with Rockwell Drill Units.

ENGINEERING AID PROVIDED

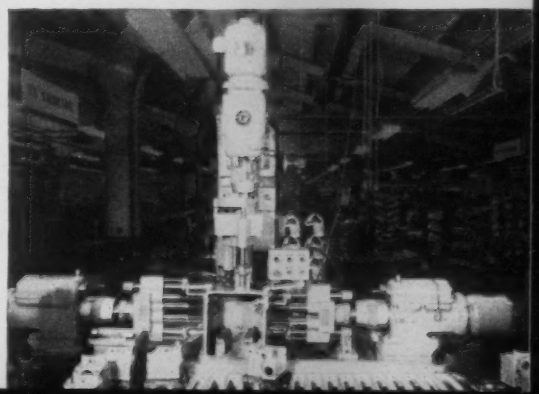
In hundreds of plants throughout the nation, the Rockwell Air-Hydraulic Drill Unit has proved that it makes possible better production at lower cost. Rockwell Drill Unit sales engineers are equipped to make demonstrations right in the plant, and to offer intelligent engineering aid in adapting the Drill Unit to production applications. Full information is obtainable by writing to: Drill Unit Division, Rockwell Manufacturing Company, 708H N. Lexington Avenue, Pittsburgh 8, Pa.

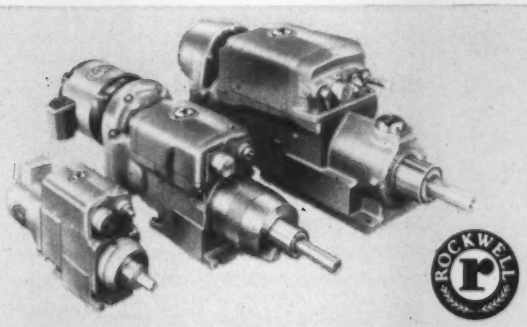


ROCKWELL DRILL UNIT SET-UPS automatically center drill and drill four holes on the piston pin end, (see C, D, E, and F in Figure 3) and two on the shaft end of forged steel connecting rods, (see A and B in Figure 3).



FOUR ROCKWELL DRILL UNITS perform 13 drilling and reaming operations on 3 facings of gear cases (see A, B, and C in Figure 4). Sealed construction permits mounting in any position.





ROCKWELL DRILL UNITS are available in 3 models, with 15 drive arrangements 1/3 . . to 5 h.p.—for maximum adaptability to individual production applications.

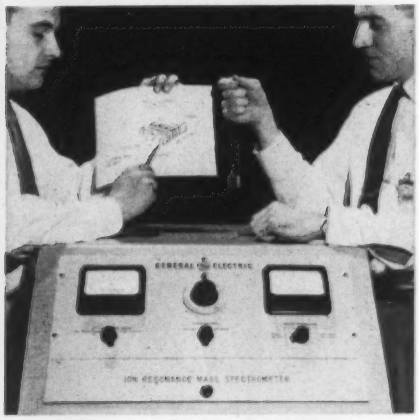
PRODUCTION RATES of 122 per hour are provided by these multiple spindle Rockwell Drill Units on 3 facings of Chain Saw motor crankcases (see A, B, and C in Figure 2). In addition to drilling the 14 holes, the Drill Units bore, chamfer, and spot face the large bore (D at top of Fig. 2).

Air-Hydraulic DRILL UNITS

Another Product by **Rockwell**

*Originally produced by Rockwell under the trade name "Delta."

AUTOMATION NEWS



NEW ROBOT CHEMIST is explained by a simple sketch and a weight attached to a spring. Like the bobbing weight on the spring, tiny electrically-charged particles of gases or light liquids have a natural frequency. In General Electric's new device the tiny particles, called ions, are formed by bombardment of molecules with electrons emitted from a hot filament. Radio frequency voltage "sorts" the ions according to their ratio of weight to electrical charge, and those having a natural frequency equal to the frequency of the voltage applied are accelerated in a dc magnetic field to a collector. The electrical signals from the collector make it possible to obtain the "signature" of the sample gas on a chart recorder.

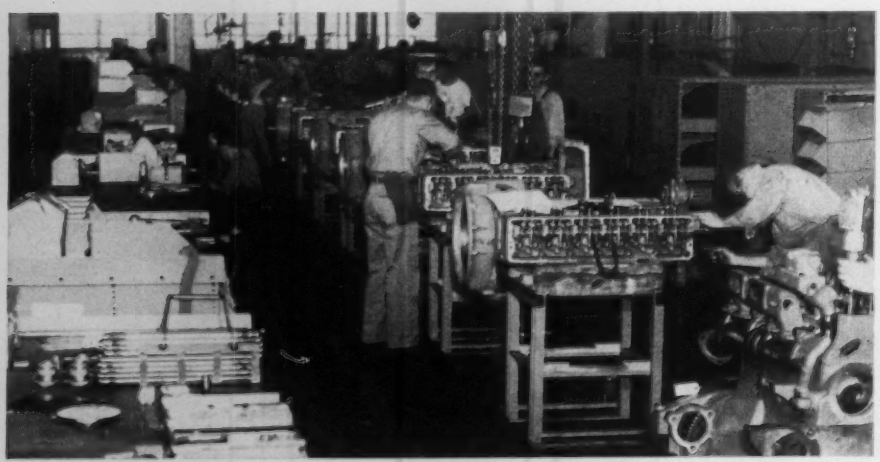
Robot Chemist Perfected

A NEWLY perfected "robot" chemist opens the door to automatic processing in the gas, petroleum, pharmaceutical and chemical industries. Developed by General Electric and called the ion resonance mass spectrometer, the instrument makes possible continuous control of the mixture in a stream of multicomponent gases or light liquids. It is designed as a primary sensing device whose signal can be used to set in motion a battery of computers and other automatic machines for complete process control.

What will it mean to the consumer? For one thing, it is expected to mean better quality plastics and synthetics at lower cost because of its wide potential application in the petrochemical industry. It promises to have a future affect on the quality and prices of such other things as motor oil and some medicines. Continuous accurate measurement of the component gases and liquids from which such products are made will enable higher production and reduce waste.

Automatic Factories Date Back To 1790

FULLY automatic manufacturing, currently in the spotlight with recent developments, actually dates back to 1790, research by the Square D Company discloses. Manufacturer of electrical control equipment of the type used to actuate automatic manufacturing setups, Square D stumbled over the facts about the grandaddy of today's automatic manufacturing in the course of research into the automation field. It was found that a man named Oliver Evans opened a completely automatic flour mill on the banks of a little creek near Philadelphia, 164 years ago. The mill was fully automatic, powered by a water wheel. Grain was fed to a bucket conveyor on the first floor of the mill. Water power moved the raw material thereafter through a succession of endless belts, screw conveyors and coarse and finish grinding operations, to the final stage. The whole plant could turn out 300 bushels an hour.



CONVEYORIZED PRODUCTION LINE 300 feet long at Cummins Engine Co. Inc., Columbus, Ind., just put into operation signalled the completion of the building portion of the company's $7,000,000 postwar expansion program. This modern assembly line is housed in a completely air-conditioned, dustproof structure, illuminated to the highest industrial standards. Cummins Diesels come down the moving line, carefully assembled under strict quality control measures. In order to insure the smooth flow of components to the production line, machinery layout throughout the plant was rearranged, and many semiautomatic tools were replaced by new high efficiency automatic equipment.

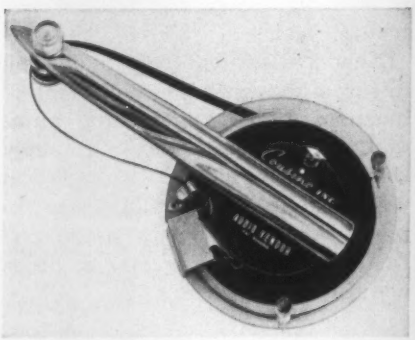
Instrument Answers Phone, Gives Reading

AN INSTRUMENT which makes it possible to telephone a remote, unattended gas holder or water reservoir and get up-to-the-minute information on the storage conditions at any time of the day or night, from any telephone, even from a radio-telephone equipped truck, is being manufactured by

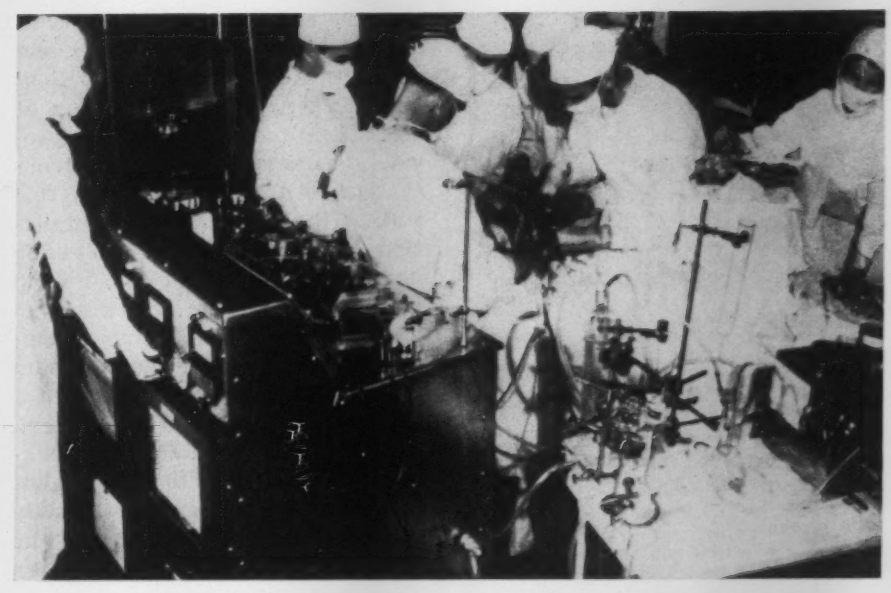
the Bristol Company, Waterbury, Conn. Called the Metaphone, the instrument can be installed at any point in a plant or system. It answers the phone and gives its reading by a time signal. The measuring system closes an electrical circuit for a length of time which is proportional to the height of the water in the tank, or to the pressure of the gas in the holder.

The electrical circuit includes a buzzer mounted before a telephone transmitter. Thus, by dialing the unattended phone and timing the signal duration with a stopwatch, the condition of the storage tank is apparent. For instance, if a 60-foot high water tank is full to a height of 40 feet, the buzzer sounds for 40 seconds, is quiet for 20 seconds, then repeats the 40-second signal.

The cost of installing and operating the device is considerably less than that of more conventional telemetering systems. Also, it is often more useful to a supervisor who doesn't stay in a central control room or pump house, but whose duties are to move about.



AUTOMATIC MESSAGE-REPEATER, embodying a magazine of magnetic tape, affords a revolutionary new means of automatic control and industrial safety promotion. The Audio-Vendor developed by Cousino, Inc., when activated by remote control, automatically and continuously repeats messages of from 15 seconds to 15 minutes. The magazine fits any standard tape recorder, and the tape is pulled from the center of a reel and automatically rewound on the outside. Perfect reproduction and completely trouble-free performance are possible with these tape loops. The unit can be activated by photoelectric cell, floor mats, etc. Frequency notes, recorded on the magnetic tape, can be used to trip various relays and activate electronic controls in proper sequence for operating automatic machinery. The tapes carrying these recorded frequencies can be filed for future use, thereby saving much time in setting up and breaking down intricate control operations involved in mechanical set-ups.



WHILE DOCTORS perform delicate heart surgery a medical technician monitors the operation of the electrically-powered artificial heart. Developed by Dr. John H. Gibbon, professor of surgery at Jefferson Medical College Hospital in Philadelphia, collaboration between science and industry made the machine possible.

Cardiac Automation

AN ELECTRICALLY POWERED man-made heart, about the size and shape of a spinet piano, packed with electronic recording and controlling instruments and safety devices, recently made medical history. The machine, actually a mechanical heart-lung combination, was used for the first time to save a patient's life during delicate heart surgery. The large instrument performed the work of the patient's heart and lungs for 26 minutes while surgeons did repair work on the empty heart.

Conceived by Dr. John H. Gibbon, Jr., professor of surgery at Jefferson Medical College Hospital in Philadelphia, the artificial heart contains four electronic controlling and recording instruments similar to those found in steel mills, food processing plants, and other industrial applications. These instruments, developed by Minneapolis-Honeywell's Industrial Div., substitute for the natural processes of the human body—automatically maintain constant temperature at the patient's normal level, balance the flow of oxygen and carbon dioxide, and regulate blood supply.

Patient's blood passes through three coils squeezed along by rollers, then falls on an upright plastic sandwich which resembles an old-style washboard. Blood flows down screens in a fine film inside the sandwich, rippled enough to absorb oxygen gently blown across the screen. As oxygen removes carbon dioxide from the blood, the purified blood turns from purple to red as happens in the human lung. Blood then flows into the fourth and last coil where the final roller squeezes it back into the patient's arteries.

According to Dr. Gibbon, the successful use of the man-made heart is the result of collaborative efforts of industry and science.

New York Subways to be Fully Automatic

THE first step toward making the New York subway train operation completely automatic is being made by installing a modern traffic control system on the Flushing Line of the IRT. This move is a result of plans laid down by Col. S. H. Bingham, general manager of the New York City Transit Authority, for modernizing the subway system.

This installation, one of the largest so far undertaken, will be made by the Union Switch & Signal Div. of Westinghouse Air Brake Co. It will allow the Flushing Line

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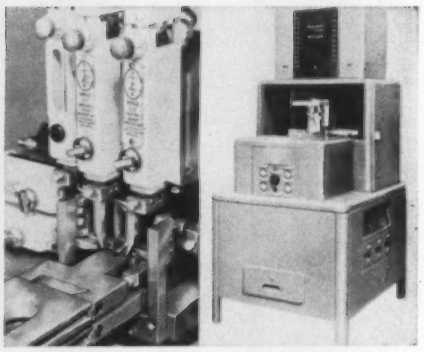
to carry more passengers faster at less cost with greater safety and comfort. According to Col. Bingham, this new modern system of centralized traffic control will provide the fastest subway train operation in America. Although this will be the system's first installation in America, it has already proved itself in the new subway in Stockholm, Sweden, where it was installed on Col. Bingham's recommendation as consultant by Union Switch & Signal.

A train identification system, which will identify the approaching train, will operate the switches without the presence of a towerman. It will also indicate on the mezzanines of the line's stations the classification of the approaching passenger train. In bad weather passengers can thus remain in the heated and sheltered areas until their train is announced.

This electronic innovation, which is called "automatic train identification," enables a moving train to identify itself as it passes wayside check-points, instantly setting up switch and signal operations that automatically show the central operator the train's location and identity. It will increase the average operating speed of all runs.

When the new traffic control system is completed, the ten mile Flushing Line will be operated from two control points, one at Times Square, the other at the 111th Street yard. Eventually, the whole line will be controlled from 111th Street. Reducing the present ten-points of control for switches and interlocking signals to two-points will result in considerable savings in operations. By allowing a more flexible operation the new two-point control system is also expected to considerably reduce the delays which are characteristic of the line's present operation.

Stations along the line are being extended to accommodate eleven-car trains, in anticipation of the forthcoming modernization of switching and signaling operations. At present, only trains of nine cars are practical. The new signal system will also allow the operation of 37 eleven-car trains an hour over the line against a maximum of 30 nine-car trains at present. These two improvements should produce a 25¾-per cent increase in passenger carrying capacity per train.



FULLY AUTOMATIC INSPECTION of accounting machine type for length, width, thickness, and straightness—a total of 6 dimensions—is done on this Sigma Instrument Co. machine. During inspection each dimension is checked by a Sigma Microlimit gage which is accurate to within 0.00005-inch and which can be quickly set to required tolerances. Speed when parts are fed into the machine from hand-loaded magazines is 2300 per hour, with hopper feeding it is 3600 per hour. Inspected parts are automatically separated into three groups—oversize, undersize, and acceptable—then dropped into separate drawers at the side of the machine. Built-in counters tabulate the number of parts submitted for inspection and the number accepted.

New developments now underway in signaling, consolidation of interlockings and the increasing automation of train operation, show the direction railroads can take in using signaling developments to meet competition with safer and faster service and greater savings, comfort and economy.

Control in Metal Finish Operation

ENGINEERED by The Foxboro Co., a one-instrument control system available in either electrical or pneumatic, automatically maintains correct temperature and concentration of blackening bath solutions. With two setting indexes, the instrument operates two control valves—one governing flow of dilution water to the bath, the other regulating flow of fuel to burners.

Concentration control is necessary because continuous boiling causes a higher concentration of salt and elevates the boiling point.

The controller, sensing this higher temperature, operates the dilution water valve to keep the boiling point (and hence concentration) at the desired value. Uniform depth of surface finish is assured and rejects cut to a minimum.

Under normal work loads and frequency, fuel needs are satisfied by a fixed setting of a bypass valve in the fuel line. However, on start-ups and during production peaks, the instrument automatically controls the fuel valve, permitting more heat without hazardous boilover or waste of fuel.

New Hand for Iron Hands

PREVIOUSLY ASSOCIATED with General Motors Corp. as master mechanic of Chevrolet-Cleveland pressed metal division, **Maurice M. Clemons** has been appointed chief engineer of Sahlin Engineering Co., manufacturers of iron hands

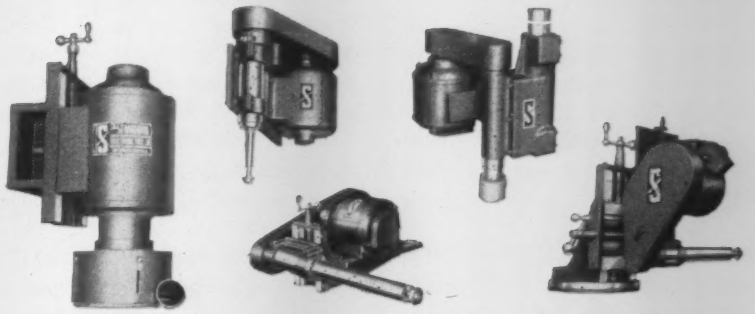
and other automation equipment. A graduate of General Motors Institute and a registered professional engineer, Mr. Clemons served as a chairman of the Joint Industry Conference for Punch Press Standardization in 1953. He is also a member of ASTE National Book Committee.

Consolidated Establishes "Systems" Unit

KEEPING pace with demands of industry, science and business for entire "systems" of automatic electronic data handling and processing equipment, Consolidated Engineering Corp. has announced the establishment of a systems design and development division within its engineering department.

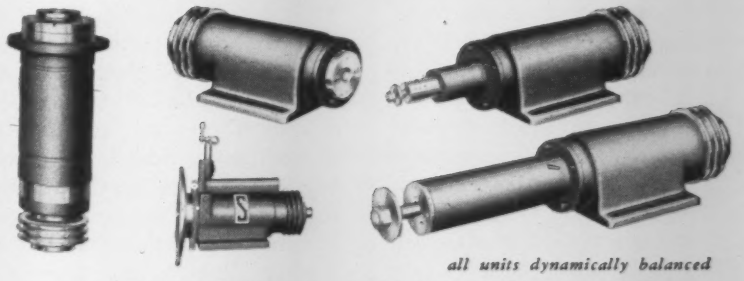
Relieving data handling equip-

precision motor driven spindles or work heads



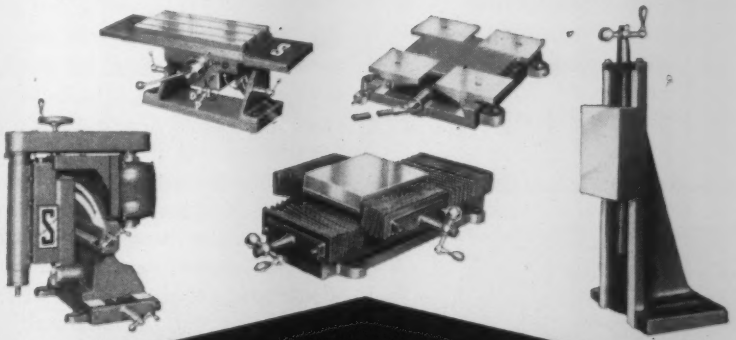
all units dynamically balanced

precision belt driven spindles or work heads



all units dynamically balanced

. . . and precision machine tool attachments



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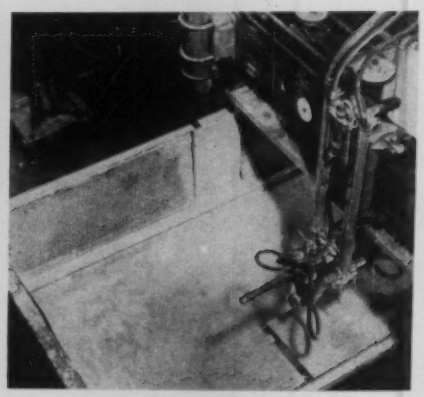
ment users of the perplexing task of selecting standard components for incorporation in systems tailored to individual needs of plant, laboratory or office, the new division will study a customer's specific requirements, design and deliver complete systems of information processing units coupled with special controls and associated input-output equipment.

The Pasadena instrument firm has engaged in extensive development work in the field of high-speed, automatic data handling and processing instruments, since 1951. The SADIC, an "electronic interpreter" which converts electrical measurements of physical phenomena into direct numerical form, has been used extensively in guided missile development work. Consolidated's SpectroSADIC provides the nation's petroleum and chemical industries with split-second conversion of mass spectrometer analyses of gas and light liquid stream components into readily usable numerical terms.

Kenneth W. Patrick has been named director of the Systems Division and will report to Joseph H. Lancor, Director of Engineering. Assistant Director is Harry W. Burke.



HORIZONTAL AUTOMATIC SPRAY BOOTH on acoustical tile line. Apparatus operating on a traversing mechanism applies the second and final finish coat to the tile, which is then moved into the final drying oven. The new, fully automatic line is part of a $500,000 expansion and improvement program of acoustical factory facilities at the Newark, Ohio, plant of Owens-Corning Fiberglas Corp. All dimensions of the tile can be controlled to within 0.0005-inch; production has been increased; appearance of the tile improved; and handling damage has been eliminated. The new line, 240 feet in length and shaped like a horseshoe, has been built to operate 24 hours a day, seven days a week.

Printed Circuits

IN THE Electronics Division Laboratories of General Electric development work is being done for the Signal Corps on a system of automatic machinery to assemble and test electronic circuit subassemblies for military equipment. This automatic factory program is based on the recognized need for vastly expanded electronic production to meet the anticipated demand in case of emergencies.

The automatic assembly system being developed for the Signal Corps will place from 10 to 50 standard components, such as resistors and subminiature tubes, on printed wiring boards at a rate of 30 per minute. This rate can be increased on any one production line by using additional placement machines. The final system also will provide for preparation and testing of components, for transporting them to the assembly machine, and for soldering and testing the completed subassemblies.

Scheduled for completion in 1955, the entire system will be supervised electronically by means of perforated cards, which will contain the various programming information. Automatic assembly with this system is not intended to produce completed products such as radar or television sets, but printed circuit subassemblies for electronic equipment. The subassemblies will be manually combined into complete products until other machines may be devised to perform the task. Subassembly type electronic equipment is desired for maintenance reasons. Faulty units are easy to locate and replace. They might be discarded at little cost, or can be repaired.

Kind of system needed to perform the job and most of the component elements have been developed. These elements, many proved, include the mechanisms to move printed wiring boards on the assembly machine, a component placement device, electronic equipment to dictate action to the machines, and various component preparation units for cutting and shaping wire leads.

The automatic component assembly system would make its greatest contribution in improved automation of the small quantity production typical of many military products and specialized commercial lines such as radio and television transmitters and studio equipment, and microwave communication equipment. Much effort has been applied to the automatic production of electronic equipment to be made by the hundreds or thousands but efforts to increase productivity of job shops have been lacking.

Designed for the greatest possible flexibility, change can be made in the subassembly the system is producing merely by punching new directions on a new program card. No retooling or operator training time would be required.

An electric "eye" that can detect tiny metal particles in packaged foods moving up to 500 feet per minute on conveyor belts has been developed by the General Engineering Laboratory of **General Electric Co.**

Conoflow Engineer Heads New Department

WITH CONOFLOW for more than ten years, **Mr. E. K. Graham, Jr.**, former chief engineer, has been named Manager of Technical Services and will head the new department which was created primarily to handle the application of Conoflow rotomotors and cylinder conomotors which are used extensively

as original equipment on catalyst valves, large gate valves, variable speed drives and pumps. Well known in the field of automatic control, he is a graduate of Drexel Institute of Technology and member of the Instrument Society of America.

NOMA Elects New President

NEW PRESIDENT of National Office Management Association, **Ralph G. Sinn** of Detroit was elected in the annual business meeting of the association's 35th International Conference.

The Detroit executive has been employed by Detroit Edison since 1916, except for service in the Signal Corps in World War I. He was named director of procedures and methods earlier this year.

In 1948 he received the Alex Dow award from Detroit Edison for work in developing recreational facilities for Edison employees.

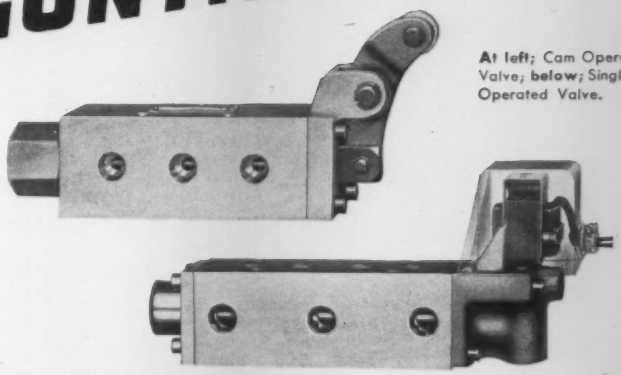
Punched Card—Perforated Tape Translator

MORE AUTOMATION in data processing procedures is possible with the Remington Rand card-to-tape and tape-to-card converters, translators of languages used by the two systems. Advantage is in combination of tape superiority in transmission and storage, with punched card superiority in tabulating.

The system is particularly suited to an operation requiring constant exchange of accounting information between distant points. A firm maintaining centralized records can utilize tape produced by local billing to create automatically punched cards for home office accounts receivable, inventory control and sales statistics. Another application is in branch order writing; tape is used to create correct punched cards at the home office or factory for production, shipment and accounting records. Still another example is in local payroll data reporting, with tape automatically creating punched cards for home office payroll writing and personnel records. A sales order can be transmitted by wire from office to plant or warehouse, and tape used in the office for punched-card prebilling and control records. Packing lists can be written in the plant, tape methods creating the punched cards in the office for billing and control records.

Interdepartmental applications within one location allow the personnel department, while typing

SELECT Quick-As-Wink® AIR AND HYDRAULIC CONTROL VALVES



At left; Cam Operated Type "O" Valve; below; Single Solenoid Pilot Operated Valve.

They're designed to give you the fast dependable trouble-free action you need for single or sequence machine movements

• Those successive and inter-related machine operations — that speed manufacture and cut costs — can only be as successful as the air and hydraulic valves that control the operations. Specify Quick-As-Wink Control Valves.

Positive and fast acting, Quick-As-Wink valves are designed and built to meet the most exacting requirements. They will deliver dependable and precision performance month after month, and year after year. Many superintendents and foremen have found that there is nothing better than a Quick-As-Wink valve. Can you afford to gamble with less? Get full details. Write for Bulletin No. 531 today!

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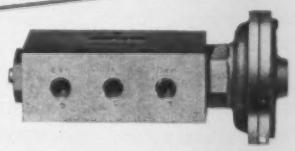
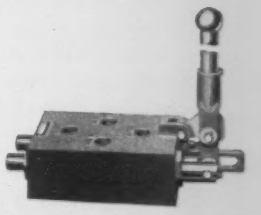


DIAPHRAGM OPERATED "O-TYPE" VALVE, diaphragm can be actuated with instrument air as low as 12 to 15 psi.



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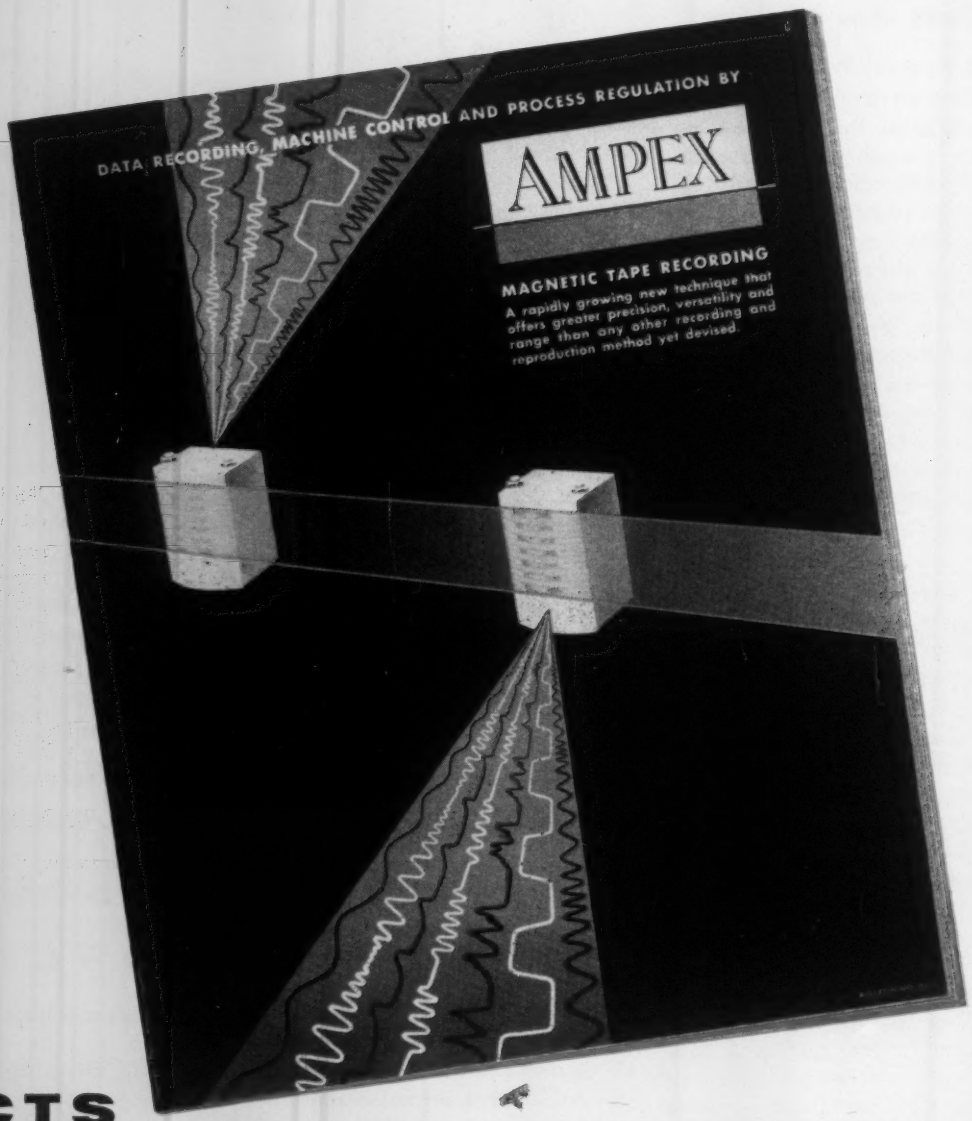
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- Magnetic recorders have long been at work recording complex data and reproducing it in its original electrical form — ready for automatic reduction and analysis.
- With greater accuracy and less cost than any other method, magnetic tape can "remember" situations encountered in your business — laboratory data, motions, processes and hundreds of kinds of information.

Get the facts in this important new bulletin from the company that has been building magnetic recorders for scientific purposes longer than any other firm. Written in clear, non-technical language, it tells what magnetic recording can do for you.

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the usual records on a new employee, to produce tape for creating master punched cards in the payroll department. The engineering department, while typing a bill of materials in the usual manner, can automatically produce a tape for creating the punched cards used for materials control.

Other equipment such as Flexowriters and standard telegraphic transmitters can be combined with converter operation.

Aluminum Big Inch by Automatic Welding

USED in laying of the 12-mile high-pressure pipeline between the White Point gas field near Corpus Christi, Texas, and the Reynolds Metals Co. LaQuinta alumina plant, a new automatic welding machine developed by Reynolds and Air Reduction Sales Co., makes aluminum pipeline competitive with steel in cost.

In an average time of 4 minutes for a five pass weld, the machine welded 40-foot sections of 8⅝-inch aluminum pipe compared to about 8 minutes or more for welding pipe by hand, the method commonly used for steel pipe. Automatic controls maintain proper conditions at the arc and when the weld is complete, the machine automatically stops, reverses itself, and returns to the starting position. Clamps are released, and the machine moves to the next weld.

Welds made during laying of the 12-mile, high-pressure link were subjected to pressure as high as 1800 psi. The 40-foot aluminum pipe sections used weigh only 320 pounds making possible savings in handling, equipment, and labor which may offset the higher cost of aluminum pipe.

ASME to Sponsor Controls Terminology

STANDARD TERMINOLOGY in the field of automatic controls will be developed by national groups concerned, it was decided at a general conference at ASA offices in April.

The American Society of Me-

VARIABLE SPEED CONTROL

for

- ✓ Tachometer Test Stands
- ✓ Dynamic Balancers
- ✓ Gyro Rate Tables
- ✓ Governor Test Stands
- ✓ Engine Simulators
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Spool features a scalloped design and built-in metering grooves, permitting easier, faster flow and reducing impact. Unrestricted passages allow greater flow capacity—¾" size rated at 28 G.P.M. at 15 ft. per sec.! Four extra long sealing surfaces on the spool provide extremely close fit with valve bore.

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2. Roomy wiring box. Dust, moisture sealed. ½" conduit connections.
3. 7 spool designs for 3 and 4-way.
4. Less pressure drop.
5. Mounted in any position.
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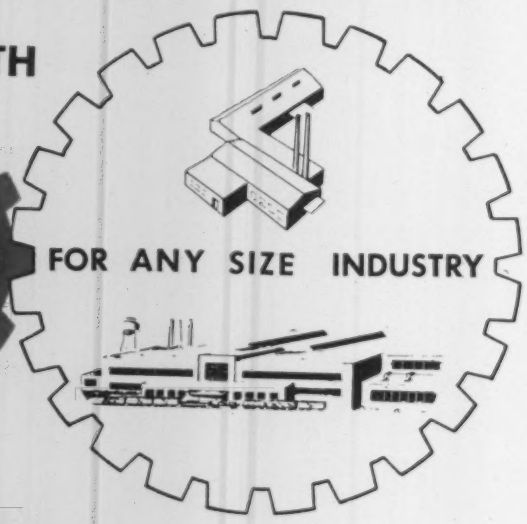
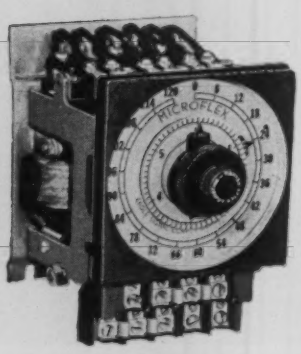
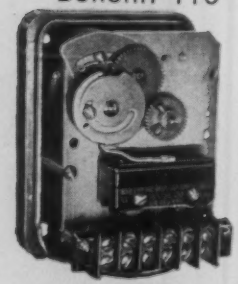




MICROFLEX
Bulletin 110



MONOPULSE
Bulletin 322

Eagle industrial timers are playing an important role in the new era of automation.

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chanical Engineers, after ten years of terminology research in this field, was elected to sponsor the project.

MEETINGS AND EVENTS

Sept. 15-21—

Instrument Society of America First International Instrument Congress and Exposition, Commercial Museum, Philadelphia, Pa. P. V. Jones, Jr., ISA, 1319 Allegheny Ave., Pittsburgh 33, Pa. is manager.

Sept. 23-26—

Packaging Machinery Manufacturers Institute. Twenty-second annual meeting to be held at Grove Park Inn, Asheville, N. C. Additional information may be obtained from society headquarters, 342 Madison Ave., New York 17, N. Y.

Sept. 27-30—

Society of Industrial Packaging & Materials Handling Engineers. Annual exposition to be held at the Coliseum, Chicago, Ill. Additional information may be obtained from society headquarters, 20 West Jackson Blvd., Chicago 4, Ill.

Sept. 28-Oct. 1—

Association of Iron & Steel Engineers. Annual convention and biennial exposition to be held at the Public Auditorium, Cleveland, O. T. J. Ess, 1010 Empire Bldg., Pittsburgh 22, Pa., is managing director.

Oct. 4-6—

National Electronics Conference. Tenth annual conference to be held at the Hotel Sherman, Chicago, Ill. Conference under the sponsorship by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University, University of Illinois, with participation by the Radio Electronics Television Manufacturers Association, Society of Motion Picture & Television Engineers, Purdue University, and University of Wisconsin. R. E. Hornacek, N.E.C., Publicity Committee, 208 West Washington St., Chicago 6, Ill., is chairman.

AUTOMATION

PATENTS

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Components

ELECTRIC CLUTCH TRANSMISSION MECHANISM

Magnetic coupling and epicyclic gear train connecting driving and driven shafts. Patent 2,672,565 by Robert Helmer assigned to Helmer Transmission Corp.

Computers

ELECTRICAL GENERATOR OF PRODUCTS AND FUNCTIONS

Two pole asymmetrically conductive devices, resistors, integrating device and generator combined in an electrical network produce a voltage representing a function of two factors comprising sources of two voltages respectively representing the factors. Patent 2,674,409 by Emory Lakatos, assigned to Bell Telephone Laboratories, Inc.

Controls

AUTOMATIC MOTOR CONTROL FOR FRACTION-COLLECTION APPARATUS

Energizes motor for indexing unit in one of two positions only, operates a predetermined number of intervals and renders control device ineffective to operate motor. Patent 2,672,581 by George Gorham assigned to Technicon Chromatography Corp.

CHECK VALVE STRUCTURE FOR MIXING VALVES

Unidirectional flow in valve mixing fluids of different temperatures. Patent 2,672,157 by Charles D. Branson assigned to Robertshaw Fulton Controls Co.

INDUSTRIAL RECORDING MECHANISMS

Multirecord recorder applies color intermittently to chart. Drive operates after each marking operation to move recording member and marking means as a unit from one of its recording positions to the color changing mechanism for color changing operation then returns to another recording position for the next marking. Patent 2,674,513 by Hoel L. Bowditch, David H. Fuller and Mead Bradner, assigned to The Foxboro Co.

AUTOMATIC PILOT

Reference means for producing a signal when aircraft departs from predetermined course. Energizes servomotors which may be either connected to or disconnected from rudder, aileron and elevator surfaces. Patent 2,674,423 by Paul A. Noxon, assigned to Bendix Aviation Corp.

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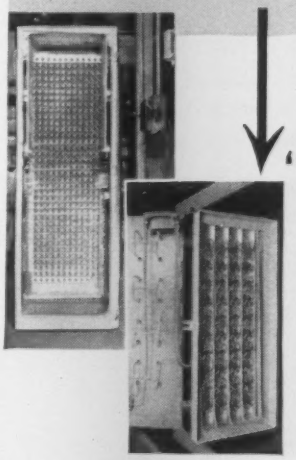
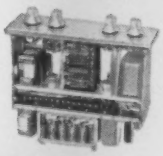
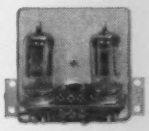
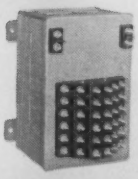


Typical "PACKAGE" Assemblies by Electro-Seal







- Counting chains (fixed or sequential)
- Test and inspection sets
- Remote telemetering controls
- Carrier equipment
- Private telephone switchboards
- Control cabinets
- Electro-mechanical controls
- Special enclosures
- Hermetic Sealing

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Data Processing

SORTING DEVICE

Items containing a plurality of sorting indices where each index includes a plurality of denominational orders are machine read and machine recorded to establish first sort. Then readers individual to denominational orders are made effective in succession to read these records and make records in accordance with another sorting index contained in each item. Patent 2,674,312 by Amos E. Joel Jr., assigned to Bell Telephone Laboratories, Inc.

METHOD OF AND APPARATUS FOR DEFINING CHARACTERS ON IMPRESSION RECEIVING MATERIAL

Stylus and plurality of character determining elements reciprocate above platen in a straight line path the length of which determines the width of the character—paper feeds between platen and stylus at a constant linear speed which determines the height of a character. Selector means determine which character determining element is conditioned to effect axial movement of the stylus to the paper. Patent 2,674,652 by William Edward Johnson and Alexander John Munro—assigned to Powers-Samas Accounting Machines Ltd.

Computers

RECORD STRIP POSITIONING DEVICE

Punched cards and perforated tape sensing means to control position of record strip and print data on that record strip in the proper location. Patent 2,672,287 by Henry A. Reitford assigned to International Business Machines Corp.

Handling

APPARATUS FOR ORIENTING PEACHES ACCORDING TO STEM INDENT AND SUTURE

Establishes the indent position, supports the fruit and rotates the suture into predetermined plane by vibrating. Patent 2,672,229 by Raymond L. Ewald and Henry A. Skog assigned to Special Equipment Co.

APPARATUS FOR AUTOMATICALLY CENTERING AND ALIGNING MOVING OBJECTS

Transversely split automatic centering roll and a pair of discs whose axes diverge away from the direction of approach of the moving object. Patent 2,672,337 by Edwin T. Lorig and Howard S. Orr assigned to United States Steel Corp.

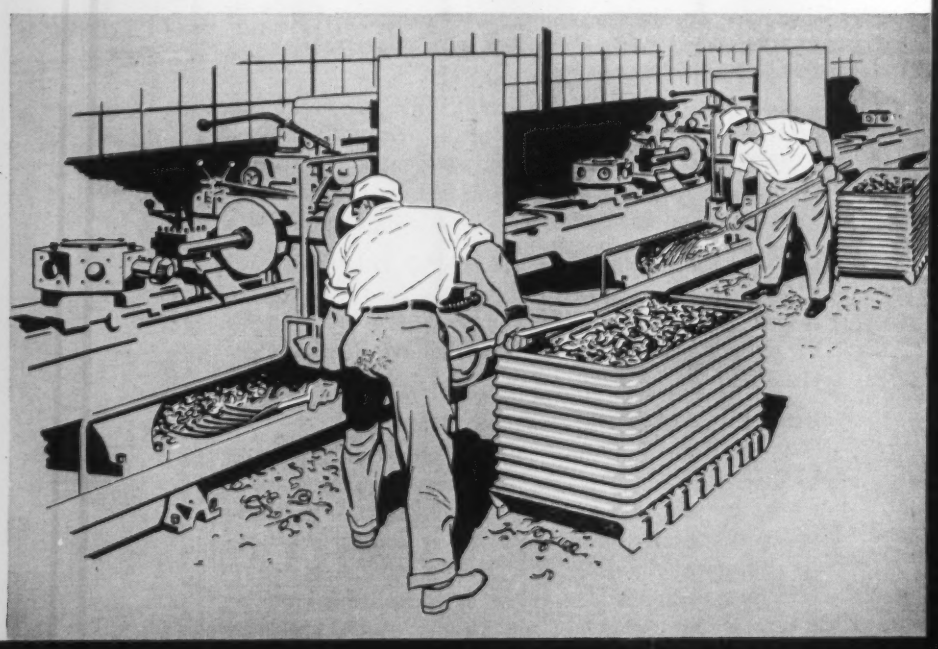
PORTABLE CONVEYING APPARATUS

Articulated chain conveyor with receiving section connected to loading machine which pulls conveyor in one direction and discharge section with power operated tramming means to pull conveyor in opposite direction alongside main conveyor. Unit serves as link between moving loader and main conveyor. Patent 2,674,364 by Frank Cartlidge, assigned to Goodman Mfg. Co.

FLIGHT CONVEYOR CHAIN

Sections of chain whose pivot links allow flexi-

MAY-FRAN



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1547-MF

bility only in the plane of the chain orbit are connected by flight carrying blocks having a pivot with axis perpendicular to the others. Patent 2,674,365 by John D. Russell, assigned to Joy Mfg. Co.

Machines

CUTOFF MACHINE FOR CONTINUOUSLY FED MATERIAL

Revolving cutter disc mounted on cammed plate moves in direction of its axis at speed similar to that of the material which is being severed. Patent 2,674,310 by Harry Scott Thornley, assigned to the Chloride Electrical Storage Co. Ltd., of England.

MACHINE FOR CUTTING SLUGS AND POSITIONING THEM ON TRANSFER SHEETS

Conveyor fed sheets have indexing marks which actuate photoelectric relay unit for control of material feeding and slug placement unit. Patent 2,674,311 by Owen H. Griswold, assigned to Technical Rubber Co.

CONTAINER CAPPING MACHINE

Means to align successive containers on conveyor beneath reciprocating arm cap closer. Patent 2,672,269 by Manuel S. Resina assigned to Resina Automatic Machine Co.

MOLDING MECHANISM

Hydraulically operated lower and upper rams move in controlled cycle in coordination with a charging box to load and mold granular material in a mold band. Patent 2,674,008 by Edward Van Der Pyl, assigned to Norton Co.

PARALLEL MOLD BLOWING MACHINE

Plasticates, feeds, divides portions, extrudes tubing into mold chambers and expands and blows organic plastic material into hollow molded articles. Patent 2,674,006 by James Bailey and Herbert A. Pratt, assigned to Plax Corp.

Machine Tools

AUTOMATIC TRAVERSE AND POSITIONING APPARATUS FOR MACHINE TOOLS

Positioning motor drives rotatable nut mounted on movable member in threaded engagement with screw shaft which is rotated by rapid traverse motor to position the movable member to an accurate position on its support. Patent 2,674,706 by Robert Knosp, Carl E. Linden and Frank O. Wetzel—assigned to The Fosdick Machine Tool Co.

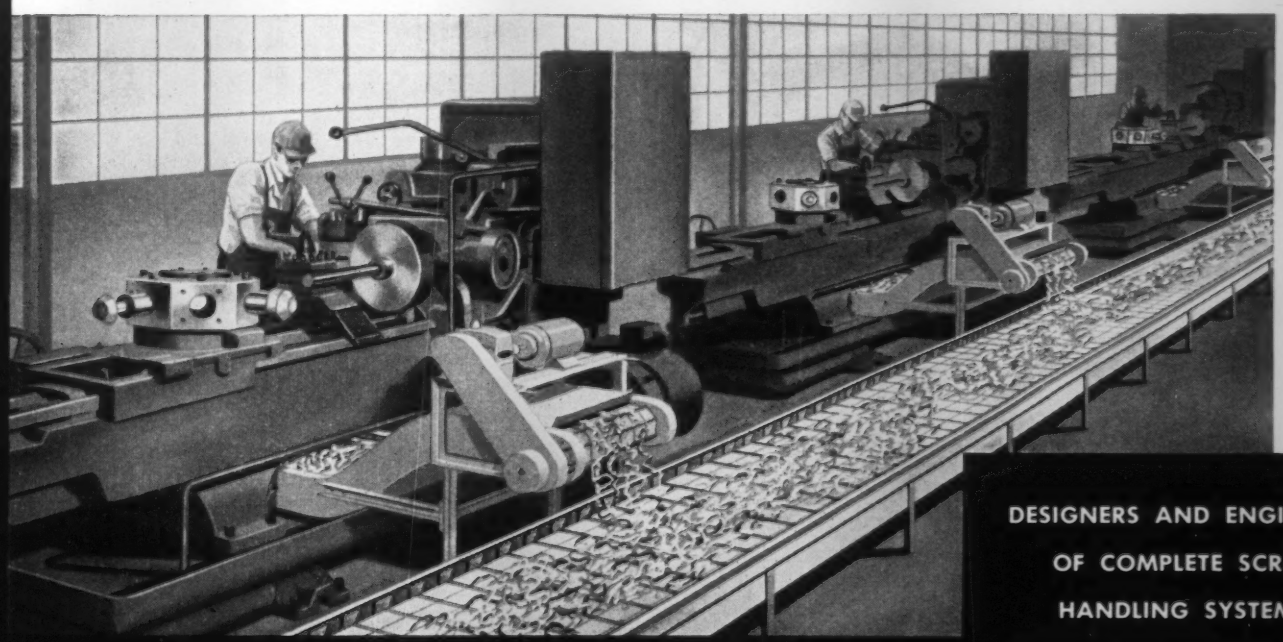
Measuring

ELECTRONIC MEASURING AND INDICATING DEVICE

Quantity is measured during first and alternate cycles and manifested during second and alternate cycles using oscillators and counters with control circuits. Patent 2,672,284 by Arthur A. Dickinson assigned to International Business Machines Corp.

MEASURING INSTRUMENT

Indicates on an equally divided scale the varia-



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Cleveland 12, Ohio

tions of a measured variable. Utilizes fluid pressure to translate movements of its various members. Patent 2,672,151 by William F. Newbold assigned to Minneapolis-Honeywell Regulator Co.

WIDTH RECORDER FOR TRAVELING WEBS

Photo-tube scanners detect lateral position of edges of web by differential reflection from surface of web and surface of guide roll. Electromechanical servo control keeps each scanner in continuous tracking relation with edge. Web width is continuously indicated by lateral spaced relation of scanners. Patent 2,674,151 by John E. Garrett and Michael B. Karelitz, assigned to Olin Industries.

Merchandising

FLUID MIXING AND SERVING MECHANISM

Various diameters of pistons with synchronized reciprocation deliver fluids to chamber where mixed with gaseous fluid under pressure and discharges mixed fluids. Patent 2,672,089 by Clarence Johnson assigned to Rockwell Mfg. Co.

LABEL APPLYING MACHINE

Coil-fed labels detached from strip, applied to article, heated to soften thermoplastic coating and secure label to article. Patent 2,672,251 by Shepard B. Schwartz and Joseph Muller assigned to May Hosiery Mills.

Packaging

APPARATUS FOR FILLING CONTAINERS WITH ICE CREAM AND THE LIKE

Gate valve built into end of filling nozzle; vertical reciprocation raises and lowers nozzle into and out of carton. Patent 2,672,262 by Frank C. Gross and Frank S. Chytil assigned to Package Machinery Co.

APPARATUS AND METHOD FOR FILLING CONTAINERS WITH PRODUCTS

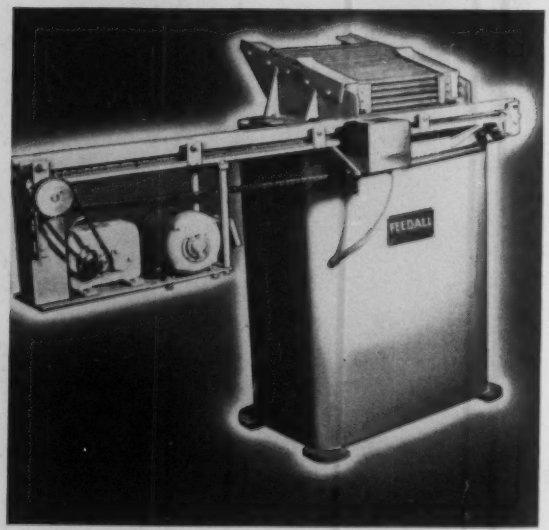
Inclined portion of conveyor separates extending flanges of cans and then overlaps adjacent flanges always in the same relationship. Patent 2,672,270 by William McK. Martin assigned to James Dole Engineering Co.

Process Design

APPARATUS AND METHOD FOR PROCESSING OF STRIP STEEL CONTINUOUSLY

Cleans metal by running continuous strips through hot molten alkali metal salt in an atmospherically open bath equipped with improved venting of waste carbon dioxide from the submerged burners; withdrawing gas from the area of the molten salt bath preventing contamination of rollers with insoluble abrasive carbonate. Tank equipped with tangential rollers above the surface of the after end to support, guide and squeeze excess salt from the strip. Provides means to heat rollers, metal strip and salt coating on both to maintain the salt molten until it enters the contiguous cold water quenching and washing tank. Patents 2,674,250; 251; 550 and 551 by Ralph Dunlevy, Harold Frick, and John H. Shoemaker—assigned to Kolene Corp.

Machines shouldn't be HAND-fed: they should be MACHINE fed . . . with FEEDALL AUTOMATIC HOPPER FEEDS



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new catalogs..... latest literature

Let us get them for you

Creative Engineering

W. F. and John Barnes Co.—Creative development, design and construction of any specialized mechanical, hydraulic or electrical equipment to individual specifications is company's function, as described in 32-page booklet. Examples of special machine tools, handling and conveying equipment, sorting, counting, assembling and gauging equipment, and electrical controls are illustrated. Booklet includes photos of ordnance plant, said to be close approach to automatic factory of the future, which company designed, built and operated for the government.

Circle No. 58 on Reply Card

Automatic Speed Control

Reeves Pulley Co.—Hydraulic and pneumatic controls, mechanical automatic controls, automatic control to maintain tension of web materials, acceleration controls, Conoflow control (a specialized pneumatic control), differential and electric remote controls can be combined with one of two variable speed units to solve any control problem, according to a 24-page booklet entitled, "Join the Swing to Automation". These combinations of controls and speed units will control tension, acceleration, deceleration, velocity and peripheral speed, will synchronize one or more machines and maintain uniform temperature and pressure.

Circle No. 59 on Reply Card

Plant Modernization

Cross Co.—When, how and why equipment should be replaced is the subject of a 16-page illustrated booklet titled, "How to Get the Most Out of Capital Expenditures". Problems of plant modernization are analyzed, and methods of establishing policies and procedures are outlined. Sample projected plans are submitted in graphic form.

Circle No. 60 on Reply Card

Control Motors and Valves

Minneapolis-Honeywell Regulator Co.—A 16-page catalog covers complete line of industrial control motors and motorized valves. Specifications, dimensions, applications and ordering information on two-position, floating and proportional control motors are given. Disc type globe, double-seated globe, internal pilot-operated, butterfly, combination globe and butterfly, and three-way valves are fully described. Schematic drawings and dimension charts are included with price list. Catalog gives information and specifications for use of various motors with specific valves or combinations.

Circle No. 61 on Reply Card

Potentiometer Noise

Helipot Corp.—"Electrical Noise in Wire-Wound Potentiometers" is a 12-page booklet covering kinds of noise which can originate in a potentiometer. Methods of observing and measuring noise, and the setting up of a system of units in which noise can be expressed are discussed. Noise is defined as any electrical signal or disturbance which interferes with generation, transmission, reception, indication or observation of the intelligence of interest. Measurable noise types are loading, shorting, resolution due to winding or load current, generated and high velocity.

Circle No. 62 on Reply Card

Electronic Computer Elements

George A. Philbrick Researches, Inc.—A revised 8-page catalog of electronic analog computing devices features two series of computing components. K3 series includes integrating, differentiating, adding, coefficient, augmenting integrator, augmenting differentiator, unit-lag, bounding, backlash, inert-zone, squaring, square-root, and absolute-value components. K4 series features dynamic, multiplying, and functional elements. Block equations and diagrams are set up as sample problems.

Circle No. 63 on Reply Card

Precision Machine Tool Attachments

Standard Electrical Tool Co.—Many variations of traverse, slides, feeds, tables, and spindles are offered on a "do-it-yourself" basis to manufacturers who wish to convert old machine tools or to design their own special-purpose tools. Units are available for manual, pneumatic or hydraulic operation. Four-page bulletin illustrates some of the models, and an assortment of grinding machines and attachments.

Circle No. 64 on Reply Card

Research Instruments

Atomic Instrument Co.—Specialists in nuclear and sub-atomic research instruments offer a bulletin displaying scalers, differential pulse height analyzers, linear amplifiers, portable radiation survey meter which features a logarithmic scale covering full instrument range, counting and control instruments, and a rapid dataprinter.

Circle No. 65 on Reply Card

Hydraulic and Pneumatic Control

Barksdale Valves—In addition to detailed descriptions and illustrations of company's line of manual, solenoid, and solenoid pilot controlled valves, a colorful 34-page manual explains and diagrams the "Shear-Seal" principle behind them. Actuation of a valve shears the fluid flow and a square external corner of the valve seat face wipes the rotor to keep sealing surfaces clean. Pressure switch selection has been simplified by means of a selection chart based on user's possible requirements. Manual is tabbed for easy identification when filed.

Circle No. 66 on Reply Card

Central Filter Control

Builders-Providence, Inc.—Control of entire filtering operation is centralized in a system which features semiautomatic or manual sequence backwashing of rapid sand water filters. Control system signals need for backwash according to loss-of-head, carries out wash cycle, and returns filter to operation. Complete details and schematic drawings included in 4-page bulletin.

Circle No. 67 on Reply Card

Hydraulic Components

Hydraulic Press Mfg. Co.—Nine separate catalogs are devoted to distinctly separate components in company's hydraulic line. Each catalog contains all basic data needed by engineer including photos, cross section views, dimensions, operating control diagrams. Subjects of individual catalogs are: pumps, motors, and power units; air and oil hydraulic cylinders (four catalogs); valves and flange connections; valves and gasket mountings; valves and threaded connections; and an engineering manual.

Circle No. 68 on Reply Card

Comprehensive Components Guide

Hydraulic Press Mfg. Co.—A condensed 28-page catalog covers entire line of hydraulic components, is meant to serve as a comprehensive guide to same products covered in detail in the nine separate catalogs described above.

Circle No. 69 on Reply Card

Circuit Breaking Handbook

Heinemann Electric Co.—A comprehensive 24-page engineering handbook on the application of circuit breakers to protective and control functions discusses principle, design and operation of company's line of hydraulic-magnetic circuit breakers. These are designed on the solenoid principle to permit a variety of circuit arrangements, ratings and time delay curves. Text is supplemented with photographs and tables of available time delay curves and minimum voltages for operation.

Circle No. 70 on Reply Card

Automatic Storage Handling

Chicago Tramrail Corp.—Automatic cranes and tracks for materials handling utilize maximum storage area and minimize aisle space and labor, as pointed out in bulletin TRC-101. Cranes can be top running or underrunning, will move up, down, forward, reverse, clockwise and counterclockwise. Many examples of operating units are shown.

Circle No. 71 on Reply Card

Automatic Drilling Unit

Dumore Co.—Ten speeds, from 400 to 7420 rpm, can be set on an automatic drill unit which will drill, tap, ream, deburr, center, counterbore, spot face, countersink and hollow mill. Drilling unit is available singly, in groups mounted in any position, or with a table as a completely universal machine. Specifications and price list included with 4-page bulletin.

Circle No. 72 on Reply Card

Design of Saturating Servomechanisms

Cook Electric Co.—A 16-page booklet entitled, "Design Considerations of a Saturating Servomechanism" takes general principles underlying multiple mode control of servomechanisms and determines optimum values with which the designer can synthesize a saturating linear servo system that will have a response approaching that of the optimum-

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10-11	25	88	102	122	137	147B	IBC
12	26	90	105	123	138	149TL	BC
13	27	91	107	125	139	149BL	

New Catalogs & Literature

ly switched servo. Relationship between saturated and unsaturated regions is shown, and method whereby the effects of torque and velocity saturation can be considered when choosing the linear parameters. Effects of various damping factors upon the saturating response are described by phase plane analysis. Phase plane allows determination of optimum response of system for a given motor and load.

Circle No. 73 on Reply Card

Automatic Press Unloading

Sahlin Engineering Co.—A 16-page bulletin discusses and illustrates a line of automatic unloaders, Iron Hands, which are installed on presses and take workpiece directly from the press after stamping. Self-contained unloaders derive their power from their own air cylinders and are independent of press for power.

Circle No. 74 on Reply Card

Electrical Energy Cell

Minneapolis-Honeywell Regulator Co.—Nuclear energy is translated directly into electrical energy by a unique radioactive sensitive element, the Ohmart cell, which is described fully in data sheet 10.0-15. Used with an electrometer and a null balance type of measuring circuit, the cell permits extremely accurate measurement of film thickness, density, specific gravity, liquid-liquid interface level, concentration of alpha, beta, gamma or neutron radiation and the composition of binary gas systems. Industrial applications, when mercury switches are added to electrometer, include control for actuation of alarms, light signals, valves, motors, pumps, and other control devices.

Circle No. 75 on Reply Card

Heavy Duty Limit Switch

R. B. Denison Mfg. Co.—Long lasting switch has "bounce" characteristics of a light duty switch and vibration resistance of a heavy duty switch. Single pole, double throw, double break switch has trigger type actuator, is said to be the most easily maintained switch on the market. Complete specifications and cutaway illustrations shown in a 4-page bulletin.

Circle No. 76 on Reply Card

Automation Timers

Eagle Signal Corp.—Application of timers in design and function of machines for automatically handling, machining or processing parts and materials is discussed in a 12-page illustrated booklet. Timers are discussed in two categories, reset or repeating cycle. Seventeen specific models are treated in detail.

Circle No. 77 on Reply Card

Indicator Lights

Marco Industries Co.—Bulletin lists and illustrates line of subminiature, miniature, standard, and special indicator lights. Valuable in electronic, nucleonic, machine and process test controlling is the special "press to test" indicator which gives instant lamp and circuit reading for quick detection of trouble.

Circle No. 78 on Reply Card

Roller Gear Drives for Indexing

Ferguson Machine & Tool Co., Inc.—Roller gear drives for use in precision indexing of automatic production machinery are described in a 24-page catalog. Drives may be applied to dial, carrier chain, feed roll or oscillating indexing systems. Catalog discusses selection of drive, calculation of load requirement (illustrated by sample problems), designing of installation, and detailed instructions on how to order a drive unit. Complete tables on load rating and on dimensions for entire drive unit or components, as well as price lists and estimate sheets, are attached.

Circle No. 79 on Reply Card

Toroidal Coils and Filters

Communication Accessories Co.—A line of miniaturized toroids and filters for electronic application is described in a 4-page bulletin. Molded plastic and hermetically sealed cases are available. Table on standard inductance values included.

Circle No. 80 on Reply Card

Cycle-Monitors

Counter & Control Corp.—Engineering data catalog covers a line of circuit controlling preset counters which will count revolutions, strokes, or electric impulses, will transfer a switch when a preset count is reached, hold switch for predetermined count without interrupting counting operation, and return switch to normal position. Cycle repeats automatically, requires no resetting or checking. Installation and operation instructions are included with prices.

Circle No. 81 on Reply Card

Productive Maintenance

General Electric Co.—Organization to meet the new demands which automation places on electrical maintenance programs is the subject of an 18-page booklet. Discussion covers the gathering of equipment data, determining amount of routine maintenance, establishing a routine operating control system, evaluating for critical maintenance, and establishing a critical maintenance program.

Circle No. 82 on Reply Card

Industrial Conveyors

Conveyor Systems, Inc.—Informative 64-page booklet is actually a condensed set of data sheets and illustrations demonstrating applications of various conveyor systems. All types of materials handling equipment are covered including trolley, roller, slat, chain, belt and special apparatus. Overhead, underground, inclined, and turning conveyors with all types of carriers illustrated.

Circle No. 83 on Reply Card

Versatile Control Valve

Controlled Flow Valve Co.—Control valve adapts to many functions, according to 4-page bulletin, simply by using different pilot equipment. Activated by the appropriate electric, hydraulic, pneumatic or thermostatic means, it will control vessel pressure, line pressure, or flow rate by automatic or manual operation.

Circle No. 84 on Reply Card

Magnets for Handling Steel

Erie Mfg. Co. — Permanent, nonelectric, magnetic equipment designed for handling and conveying steel, and proved to withstand abrasion, heat, and acid fumes, is described in a 36-page illustrated booklet. Study shows that steel handling equipment using these magnetic units can increase production and efficiency while reducing downtime, labor force, operating cost and accidents. Suggested applications to skelp mills, continuous and noncontinuous butt weld pipe mills, sheet and tin mills include illustrative schematic layouts of the operations.

Circle No. 85 on Reply Card

Study of Automating Plants

T. A. B. Engineers, Inc.—An engineering firm has published a concise, 4-page booklet to aid executives in understanding the current significance of automation and in determining whether their factories can be adapted to it. "Cut Costs with Automation" discusses the history and evolution of automation, and contains a check list questionnaire to help evaluate reader's own company, plant and product to determine the practicability there of automation or partial automation.

Circle No. 86 on Reply Card

Oil Free Compressed Air

Pennsylvania Pump & Compressor Co. — Compressed air or gas for instruments is guaranteed to be free from all traces of oil or oily vapors due to lubricants when Oilfreair compressors are used. These horizontal, double acting compressors may be single or two-stage, and feature steel backed carbon cylinder liner for floating piston and piston rod assembly as described in 6-page bulletin.

Circle No. 87 on Reply Card

Automatic Drilling, Tapping Unit

HyPneuMat, Inc.—Automatic unit performs tapping, drilling, centering, reaming, end milling, chamfering, counterboring, multi-spindle drilling operations with hydraulic or pneumatic power. Diagrams, specifications, and prices given in descriptive catalog, which also illustrates special models with heavy-duty strokes as deep as 25-in.

Circle No. 88 on Reply Card

Automatic Materials Handling

Gifford-Wood Co.—Well illustrated and diagrammed bulletin describes line of materials handling systems and accessories. Systems to carry bulk chemicals, chips in metalworking industries, drums in chemical processing plants, raw materials for can manufacturers, bulk-grain in the brewing industry, coal for industrial plants, sand and flask in foundries, and trays in textile mills are covered thoroughly. A section on transferring and feeding devices and bucket elevators completes bulletin.

Circle No. 89 on Reply Card

Automatic Multiple Plunger Presses

Waterbury Farrel Foundry & Machine Co.—Complete specifications and capacities for six multiple-plunger pillar presses are presented in tabular form in an 8-page bulletin. Examples of work produced, close-up views of tooling arrangement and accessory equipment are illustrated.

Circle No. 90 on Reply Card

Automatic Heat Controls

Bristol Co.—A complete line of automatic control instruments designed for use with furnaces, ovens, dryers and kilns is described in a 48-page booklet. Catalog covers pyrometer and thermometer controllers and recorders used on fuel-fired and electric equipment. Complete design data for electric and air-operated potentiometers, noncontrolling potentiometer recorders, millivoltmeter controllers, noncontrolling millivoltmeter indicators, ranges, charts, scales, switches, thermocouples and accessories and radiation pyrometers included. Thermometer equipment includes electric and air-operated bulb-and-tubing type controllers, noncontrolling recording thermometers, humidity recorders and controllers, thermometer bulbs and tubing, charts and scales. Control valves, combustion safeguards and panels for instruments are discussed.

Circle No. 91 on Reply Card

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Thermocouple Calibration

Bristol Co.—Thermocouple calibration data have been compiled in tables based on data released by National Bureau of Standards and adopted by SAMA and ISA. Tables cover iron-constantan, copper-constantan, chromel-alumel, platinum-platinum 10 per cent rhodium and platinum-platinum 13 per cent rhodium thermocouples. Brief summaries of company's dynamaster recorders and controllers are included in 12-page bulletin.

Circle No. **92** on Reply Card

Low Capacity Control Pumps

Milton Roy Co.—Bulletin contains 16 pages on air-powered, controlled volume pumps for low-capacity flow control problems. Capacities range from three milliliters per hour to 45 gpm, and pressures run from a few pounds psi to 25,000 psi. Description and specifications of complete line of pumps are supplemented by graphic presentation of pump operating principles and capacity-pressure and air-consumption tables.

Circle No. **93** on Reply Card

Flexible Shafting Slide Rule

Stow Mfg. Co.—A slide torque calculator is included with this 12-page bulletin on flexible shafting for power drives and for remote control. Complete data on how to select the correct size and type power drive flexible shaft for any application with a maximum capacity of 1500 lb-in., and data on remote control of flexible shafts with maximum capacity of 4000 lb-in., are given.

Circle No. **94** on Reply Card

Metal Surface Cleaning

N. Ransohoff, Inc.—Graphic presentation of design and manufacture of complete line of metal cleaning machines. Drum and batch type washers, conveyorized wash-rinse-dry machines, monorail machines, automatic wash-pickle-neutralize-phosphate coat units, cabinet "walking spray" models, conveyorized continuous picklers, deburr-burnish-rinse-dry machines, clean-polish-weigh models for nails, strip washers, chip washers and separators, automatic star return wet method foundry cleaning mills, are illustrated in this 48-page catalog.

Circle No. **95** on Reply Card

Relays

Leach Relay Co., Leach Corp.—A loose-leaf, 44-page catalog describes and illustrates standard relays and suggests modifications which can be made on stock models to accommodate special requirements. Schematics and dimensions for midgets, circuit controls, special purpose, radio and high frequency, aircraft relays and contactors are included.

Circle No. **96** on Reply Card

Foundries Automated

Link-Belt Co.—Equipment for mechanization of ferrous and nonferrous foundries and resultant increased production of better castings are covered in a 40-page book. In addition to descriptions of sand preparation and mold, core, casting and sand handling equipment, book contains over 70 illustrations of actual installations. Seven tested foundry layouts for different type and capacity operations are included.

Circle No. **97** on Reply Card

Vibrating Conveyors

Hewitt-Robins Inc.—Well illustrated booklet describes a line of vibrating conveyors that will handle hot or cold, wet or dry, pulverized or lump, packaged or loose materials. Running on relatively low horsepower, these units remain constant under heavy fluctuating loads, level out batch feeds, can be installed as double deckers with top level used as work table.

Circle No. **98** on Reply Card

Leakproof Tube Fittings

Samuel Moore & Co.—Tube fittings said to withstand more vibration than compression or flared type fittings are described in bulletin L-9335. Fittings are quickly assembled, disconnected and reconnected without leakage. Sectional views and installation instructions included.

Circle No. **99** on Reply Card

Comprehensive Demineralization Study

Graver Water Conditioning Co.—Removal of ionized, dissolved solids from liquids is subject of a 24-page booklet. Applications include procurement of quality process water and boiler feedwater, demineralization in low-makeup and high-makeup boiler plants, and purification in the manufacture of fine chemicals, cosmetics, pharmaceuticals, inks, plastics, paper and television tubes. Estimated operating costs of various systems, including automatic and remote control, and itemized accesories and equipment included.

Circle No. **100** on Reply Card

Selenium Rectifiers

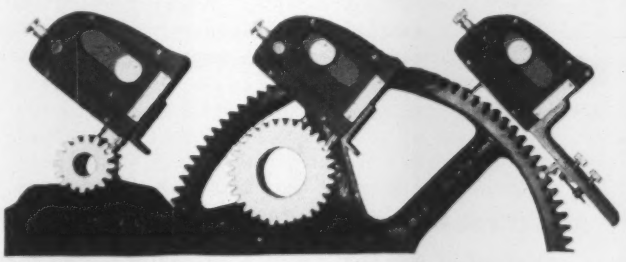
Fansteel Metallurgical Corp.—Well illustrated and diagrammed, this 24-page booklet covers operating principles, installation and care of selenium rectifiers. Typical rectifier circuits, test circuits and characteristic curves are set up as well as charts covering standard cell sizes and ratings, formulae and constants for design engineers.

Circle No. **101** on Reply Card

High Resolution Potentiometer

DeJur-Amsco Corp.—Precision, high resolution, low torque, 3-in. potentiometer achieves exceptionally high winding resolution for fine settings or readings with good linearity. Illustrated bulletin offers complete specifications and working diagram.

Circle No. **102** on Reply Card



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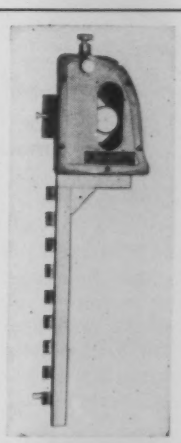

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- **Machine Mobility for Automatic Production** ..... JOHNSON
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NEW BOOKS

PRINCIPLES OF AUTOMATIC CONTROLS

By Floyd E. Nixon, electro mechanical group engineer, The Glenn L. Martin Co.; 409 pages, 6 by 9 inches, clothbound; published by Prentice-Hall, Inc., New York; available from AUTOMATION, *$9.35 postpaid.*

This book discusses the principles utilized in the design of automatic control systems. Starting with simple control systems defined by mathematically soluble equations, the author goes on to more complicated systems requiring interacting equations whose solutions are difficult in terms of conventional methods. The book covers frequency and transient response methods, stability criteria, proper gain adjustment, compensating methods, effect of noise and extraneous inputs, numerical integration, automatic computers, methods for analyzing transient response data, and nonlinear systems. Appendixes feature design data for cascaded compensating functions, a table of Laplace transform pairs and the derivation of the Nyquist criterion.

A TEXT-BOOK OF RADAR

By Staff of the Radiophysics Laboratory, C.S.I.R.O., Australia; second edition edited by E. G. Bowen; 617 pages, 5½ by 8¾, inches, clothbound; published by Cambridge University Press, New York; available from AUTOMATION, *$8.50 postpaid.*

First published in 1947 as a comprehensive study of all technical aspects and components of radar, this revised edition has added nearly 100 pages dealing with the practical applications of radar and emerges as an authoritative handbook for all research and development engineers in industry. Civil applications of radar include aerial and marine navigation and surveillance, and survey of inaccessible terrain. Application of entire radar systems or one or more techniques to physical science include measurement of physical qualities, e.g. velocity of electromagnetic waves, ionospheric research, procurement of echoes from meteors and the moon, detection of rain for meteorologists, and study of radio astronomy. Military coverage discusses ground based systems for warning, positioning and fire control, naval systems for navigation, warning, fire control and sea search, and airborne systems for interception and navigation. Following introduction which describes early study of radar culminating in war developments of the '40's,

book moves on to study development and varieties of magnetrons, triode power oscillators, pulse network and "hard tube" modulators, cavity resonators and microwave transmission, aerials (elementary units, continuous duty models, and arrays of radiators), aerial duplexing for transmission and receptance via one unit, receivers, frequency conversion, amplifiers, display circuits and automatic ranging circuits. Text is written with clarity and interest, is well illustrated with plates and diagrams.

♦

DISCONTINUOUS AUTOMATIC CONTROL

By Irmgard Flugge-Lotz, Stanford University; 168 *pages,* 6 *by* 9 *inches, clothbound; published by Princeton University Press, Princeton, N. J.; available from* AUTOMATION, $5.00 *postpaid.*

Simplicity, economy and ruggedness of discontinuous controls over continuous controls have long appealed to engineers, particularly in association with expendable equipment such as missiles. However, complexity of the predictable effects of on-off controls on a controlled system often prevents their use, complexity which the author strives to overcome by using effective graphic solutions instead of elaborate mathematical computations to show that choice of control characteristics can offset undesirable phenomena. She deals with two systems, a moving body with a single degree of freedom and a moving body with more than one degree of freedom, and with two types of on-off control, position and velocity. Three types of imperfection in these systems are 1) a constant lag dependent on value of control function, or threshold imperfection, 2) a direct time lag, and 3) a neutral zone. All these imperfections can be directed to reduce the disturbance by choosing correct control characteristics, even in the neutral zone which can be compensated for with a time lag. In dealing with bodies with more than one degree of freedom, author uses spirals corresponding to their natural frequencies to study the motion. Phase space is used to study and plot influence of physical factors on a system's performance.

♦

TEMPERATURE MEASUREMENT IN ENGINEERING

By H. Dean Baker, professor of mechanical engineering, Columbia University, E. A. Ryder, consulting engineer, United Aircraft Corp., and N. H. Baker, research assistant, Columbia University; published by John Wiley & Sons Inc., New York; available from AUTOMATION, $3.75 *postpaid.*

First of two volumes, this book accurately discusses temperature in terms of engineering measurement. Stress is placed on specific procedures and techniques involved in producing satisfactory temperature-measurement designs for various circumstances. Types of measurement conditions encountered are classified on a physical basis such as interior points in solids, liquids, gases, flame, etc., rather than specific industrial problems or relations to various types of instrumentation. Volume I deals primarily with the thermocouple technique since it is most widely employed to measure internal temperatures of solid bodies.

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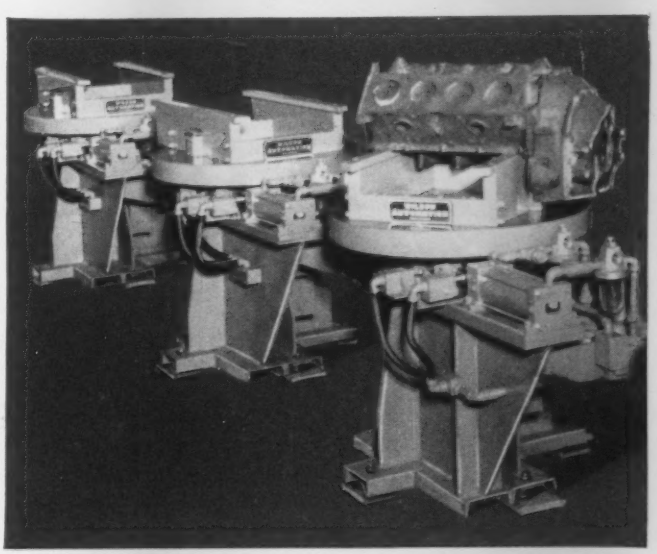

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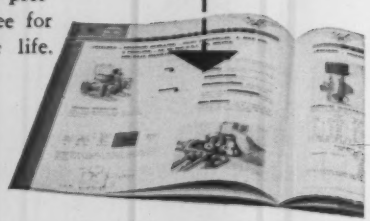

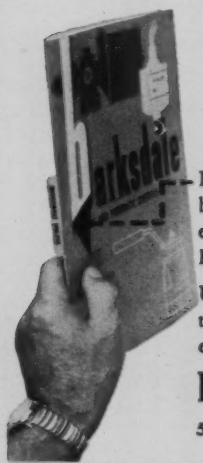

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TIMING ENGINEERING

By Myrten G. Saake, application engineer; 243 pages, 6 by 9 inches, clothbound; published by the Ribble Engineering Co., Jersey City 2, N. J.; available from AUTOMATION, *$5.00 postpaid.*

Repeating cycle and automatic reset timers are studied from design, construction and application points of view as relating to automated machines and processes. Engineers wishing to employ timers but in doubt as to choice and performance will find here six basic points to be considered in choice of a timer as well as detailed descriptions of performance and circuit diagrams of various applications. Largest timing area covered is that of versatile synchronous motor driven reset timers. These are classified into microflex, cycl-flex, timoflex, duroflex and manuflex. Multiflex and polyflex multiple circuit reset timers, and dc timers are discussed, and a chapter is devoted to shaft driven automatic counters for use in conjunction with timers or as separate units. Book closes with brief description of timers which are not synchronous motor driven and which perform dependably for time intervals under 15 seconds. These include electronic, pneumatic and thermal timers.

♦

INSTRUMENT ENGINEERING

By C. S. Draper, W. McKay, and S. Lees, Massachusetts Institute of Technology; Volume I—285 pages, Volume II—855 pages, 8½ by 11 inches, clothbound; published by McGraw-Hill Book Co., Inc., New York; available from AUTOMATION, *Volume I—$7.00, Volume II—$15.00 postpaid.*

In Volume I fundamental principles and methods are covered for various instrument engineering situations. A system of measurement and control concepts, notations, diagrams and mathematical forms are developed for describing the performance of physical devices and variations in physical quantities.

Methods for associating mathematical solutions with common forms make up the contents of Volume II. This is a comprehensive source of information on effective methods and techniques for solving integro-differential equations that commonly appear in descriptions of the behavior of physical systems with "lumped coefficients". Typical results are developed with enough detail to save much routine effort. At the same time attention is called to the place of each example in the general pattern of procedures for finding solutions of typical equations.

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ELECTRICAL ENGINEERING

By Fred H. Pumphrey, professor of electrical engineering, University of Florida; 416 pages, 6 by 9 inches, clothbound; published by Prentice-Hall Inc., New York; available from AUTOMATION, *$8.00 postpaid.*

A second edition, this book presents fundamental electrical engineering theory along with applications of that theory in commercial practice. The first twelve chapters review basic theory of dc and ac measurements, circuits, generators, and motors. Chapter thirteen covers electric motor characteristics, hous-

ings, ratings, control, and selection. The final chapters include material on electron tubes and circuits; heating, welding, and electrochemical processes; electrical illumination; industrial electrical measurements; industrial wiring systems; and electric power and its economics and maintenance.

•

SYNCHROS, SELF-SYNCHRONOUS DEVICES AND ELECTRICAL SERVOMECHANISMS

By Leonard R. Crow, director of research and development, Universal Scientific Co.; 5½ by 8½ inches, 232 pages, clothbound; published by the Scientific Book Publishing Co., Vincennes, Ind.; available from AUTOMATION; *$4.20 postpaid.*

This book discusses the basic self-synchronous electrical mechanisms and many special synchros and devices that evolved from the fundamental forms. Principles underlying the functional operating theory are given as well as the use and application of synchros and allied self-synchronous electrical mechanisms. Structural features are described in sufficient detail for understanding of the function and application of the many types and forms of self-synchronous devices.

Government Publications

A Survey of Automatic Digital Computers. *Report PB 111293 by Office of Naval Research; 115 pages; available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.;* $2.00.

Operating data on many current automatic digital computers for general computation include builder, location of machine, word length, instruction type, sequence control, speed and storage type.

•

A Digital Electronic Data Recording System for Pulse-Time Telemetering. *Report PB 111294 by Air Research and Development Command; 47 pages; available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C.;* $1.25.

High speed telemetering recording and reduction equipment for rocket flights gathering upper air data can be modified for laboratory use or for romote recording of hazardous operations. System consists of two units. First unit accepts data, converts it to code, and provides a permanent film record. Second unit reads coded data photoeletrically and produces typewritten tabulation of telemetering voltages.

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Instrumentation—Technical Report on Seismology, No. 10. *Report PB 112445 by Columbia University for U. S. Air Force; 43 pages; available from Library of Commerce, Publication Board Project, Washington 25, D. C.;* $2.50 *per microfilm,* $6.25 *per photostat.*

Instruments which have been developed for observatory and field observation of earthquakes, microseisms and wave propagation in general are described in this report. Instruments include a field seismometer, amplifying and recording gear, a 3-component electromagnetic seismograph made from a pair of Bosch-Omri seismographs, and a mechanical low-frequency oscillator.

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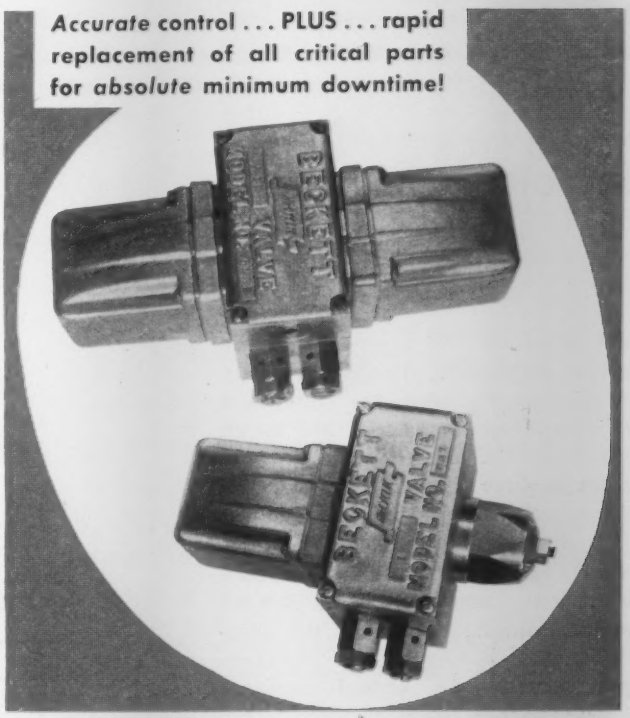

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ABSTRACTS

TRANSISTORS IN CONTROL CIRCUITS

By DR. R. L. BRIGHT
Westinghouse Electric Corp.
Pittsburgh, Pa.

IT HAS NOW been six years since the Bell Telephone Laboratory announced the invention of the transistor, acclaimed as an all powerful device which would soon replace the vast majority of vacuum tubes in all types of home, industrial, and military equipment. During these six years electrical manufacturers have spent millions of dollars on semiconductor research and development, and the armed services have spent several million more. In spite of this enormous effort, there is almost no commercial equipment containing transistors, with the exceptions of hearing aids and computers. The reason? It is simply that a transistor is not a vacuum tube. It has some characteristics that are similar to those of a vacuum tube, but it also differs in many important respects. The grid of a vacuum tube draws practically no power from the signal source; a transistor, on the other hand, requires a small but often appreciable power. In most applications, the vacuum tube characteristics may be considered invarient with temperature; some of the transistor's properties vary greatly with temperature.

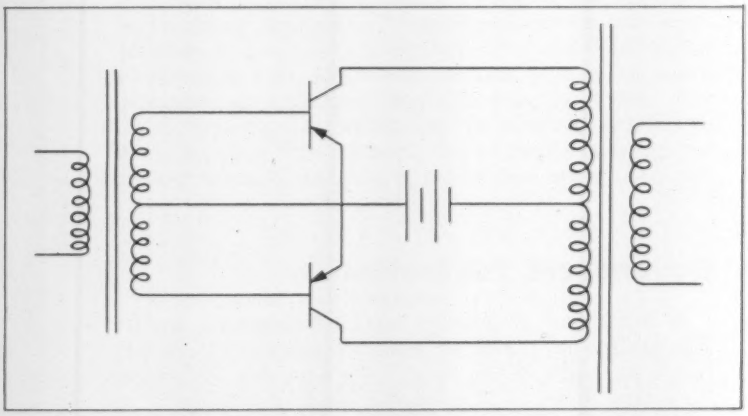


Fig. 1—Circuit diagram of two switching transistors used to make a variable-frequency power amplifier

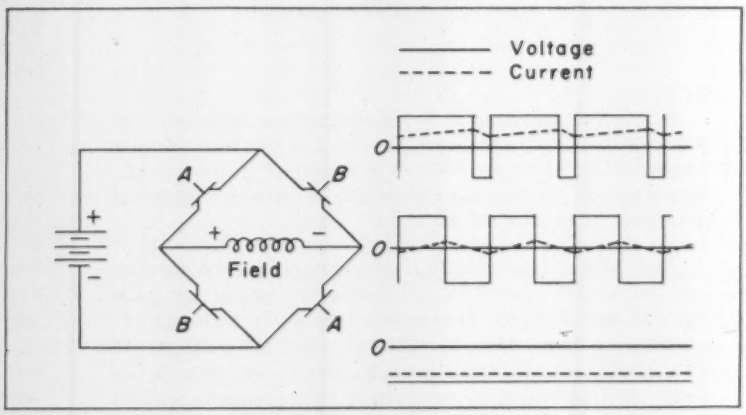


Fig. 2—A static field control circuit using transistors. Typical wave forms are shown on the right

Transistors In Switching

One of the major obstacles in the application of transistors has been the difficulty of obtaining a stable operating point since the entire family of voltage vs current characteristics moves considerably with temperature and may differ significantly from unit to unit. It should be emphasized that transistors when used as switches are not subject to the severe temperature restriction which is generally accorded them and which apply to linear amplifiers. On the contrary, in many applications, such transistor circuits will meet most military specifications. Furthermore, the transistors do not need to be carefully selected. In switching service, all transistors of a given type will be completely interchangeable.

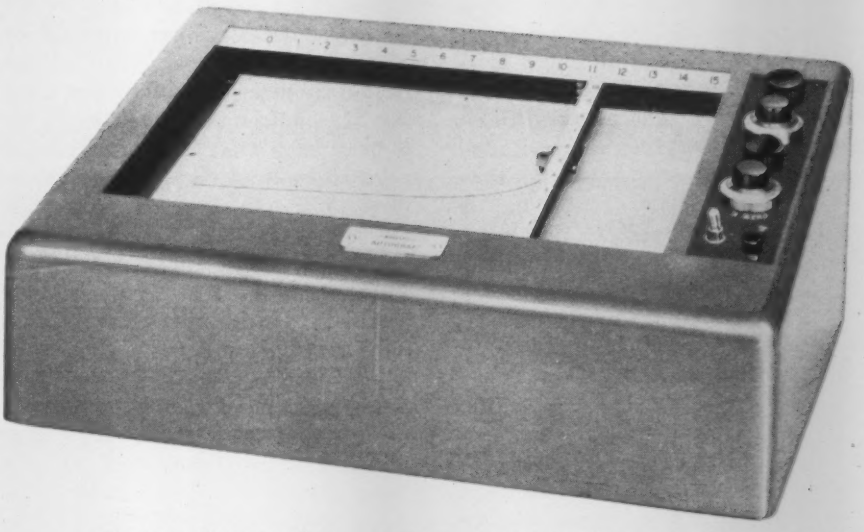
An obvious application of this device would be to replace a relay and take advantage of the fact that a transistor can operate at very high speeds and has no

contacts to pit or get dirty. The transistor has the limitation that it is only a three terminal device and, hence, it must have one lead common to both input and output. Furthermore, it effectively carries only the one contact. Nevertheless, many power control circuits can probably be redesigned to incorporate such units.

Circuitry Applications

Two such switching transistors can be used to make a variable-frequency power amplifier as shown in *Fig.* 1. If a square wave is applied to the input of this circuit, the two transistors are alternately turned on and off, thereby connecting the supply battery to alternate ends of the winding, and thus, producing a square wave at the output of the same frequency but of a much higher power than the input. One possible application of this device might be as a component in a tape-controlled machine tool. For example, speed information could be recorded on the tape as a square wave of variable frequency; the pickup head might feed into an all transistor amplifier having two or three stages of the type just shown. The output of this amplifier could drive a synchronous motor at the required speed. This system would provide a precise speed control without the complexity of a feedback loop.

A static field control circuit that may replace rotating amplifiers and exciters is shown in *Fig.* 2. Here, advantage is taken of the fact that the transistor can pass current in either direction and, hence, can perform functions which are not now practical with thyratrons. In this circuit, the base-drive circuits which have not been shown in detail are such that transistors A & A' are closed while B & B' are open and conversely. If A & A' are closed, the battery is connected across the field so that the field polarity is as shown; if B & B' are closed, the field has the opposite polarity applied. Thus, this circuit functions similarly to a double-pole, double-throw reversing switch with the one outstanding difference that it can be thrown practically instantaneously. That is, the polarity



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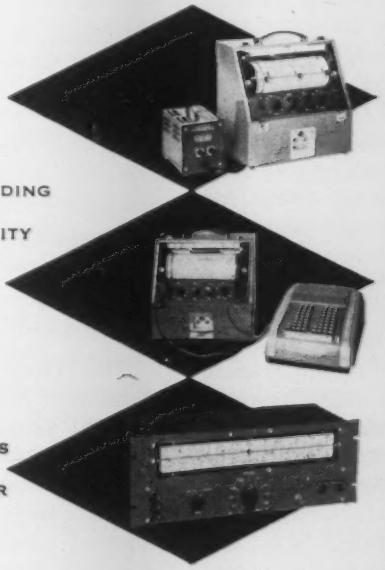

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of the field can be reversed without ever opening the field circuit. Thus, there will be no high-voltage surges and no discontinuities in the current. The average field-current can therefore be controlled by varying the ratio of the time that one polarity of voltage is applied to the field to the time the other polarity is applied. Typical waveforms are shown on the right-hand section of *Fig.* 2. If the frequency of these rectangular voltage waves is very high compared to the reciprocal of the time constant of the field, the field-current will have very little ripple. This bridge can be held closed in either position and, hence, can apply full forcing to the field in either direction. A voltage regulator containing an exciter of this type would essentially contain only one time constant—that of the field winding itself.

Another entirely different industrial application of transistors and one which is not in the future but is fully practical today is the use of phototransistors in place of photocells. A transistor of the finger tip size previously described has a photosensitivity only slightly less than that of a photomultiplier tube and far greater than any other available device. They are extremely sensitive to an incandescent lamp even when it is glowing only a dull red. Such phototransistors are in many cases capable of operating quite rugged relays directly with no intermediate amplifiers and require only 6 to 12-volt supply. The extreme reliability and small size of this device may open up many more applications of light actuated devices in the machine tool control field.

From a paper entitled "Future Applications of Transistors to Control Machine Tools" presented at the Annual Machine Tool Electrification Forum sponsored by the Westighouse Electric Corporation in Buffalo, N. Y., April, 1954.

SUPERVISION IN THE AUTOMATIC FACTORY

By G. H. GUSTAT
Industrial Engineering Div.
Eastman Kodak Co., Rochester, N. Y.

THE TERM "automation" has swept the country and it is difficult to pick up a technical periodical and not find in it some use or description of the term. I suspect that, like all the new words and expressions that come along, it is a new word for something that most of us have been doing for some time and while the push button or one-man factory definition is an ideal, up to this point, it has not been achieved. Hence, if we can define automation or an automatic factory as one in which some of the processes or operations are controlled automatically or partially controlled then we are perhaps nearer to the present status of automation in our factories.

After the first world war, the increasing demands for chemical products were such that the old batch methods could not meet them and we witnessed a change to a continuous form of production. This trend has continued to the present time and has been characterized by the following:

1. Much higher capital investment per worker.
2. High research expenditures.
3. Development of new products.
4. High value of output per worker.
5. Higher maintenance costs.
6. High ratio of technically trained employees.
7. Trends toward continuous automatically controlled processes.

This trend has resulted in the American workers gaining more wealth, simply because they produce more wealth, and they are able to produce more, because these modern tools and methods of production have multiplied their strength enormously. Today, each of these workers is the boss of an invisible crew of mechanical men, whose energies he commands at the flick of a switch, and whose productive efforts enrich his life.

Supervision Problems

These changes have had many different effects on the workers, on owners of the businesses, on the public, and on supervision in our industries. They generally have resulted in lower costs, improved and new products, safer operation—and more supervisory or administrative headaches.

Top management personnel must continue to have the faith to invest, often huge sums of money, in new and improved equipment that will produce more and more wealth which in turn raises our standard of living and provides continuing employment for greater numbers of people. It is not always easy to have that kind of vision or to sell it to conservative boards of directors.

The burden of timing changes to prevent displacing labor by absorbing them in increasing production schedules falls upon this group. In the days of the old hand crafts, a worker had skills that were common to almost any industry and it he lost his job, he had know-how that made it relatively easy to get another job. In the automatic process, we make a specialist out of him; e.g., a coater, a machine tender, a control man, and so on. These are skills that are unique to a given industry and which the man cannot use in another. This imposes a serious obligation on supervision to be careful of any change that may displace this labor. This again calls for considerable foresight and involves, as you know, considerable risk.

As our factories have become more automatic, it has been necessary to make a change in the type of supervision employed. There was a time when the best workman usually became the foreman when a vacancy occurred. While the validity of such a method of selection is questionable, the workman who became foreman, as long as the operation was simple and unmechanized, usually had enough background to understand and direct the job. When you have operations that are automatically controlled by complex instruments, it is highly desirable to have considerably more background in your supervision.

Changes do not occur overnight and with careful planning, technically trained men can be worked into the line. There are several ways in which this can be done. As present supervisory jobs are left open, replace with technically trained men. Where present supervision cannot be replaced, they can be given technically trained staff assistants who will some day replace them. In some instances, staff departments furnish the technically trained staff for the necessary control. In any event, it is a problem that automation creates for the supervisory staff. The current shortage of young engineers is creating a problem for both supervision and top managements because it is this type of personnel that helps to design, install and maintain automatic equipment.

Teamwork Approach

Of course, it must not be construed that engineers alone will do the job. Automation is accelerating a change in the philosophy of the individual doing the job to the team doing the job. It emphasizes, as never before, the importance of supervision, technical men, operators and staff department personnel working together as a team. This is especially true of the operators, because the automatic equipment is usually operated by several individuals as a team.

Automatic equipment is usually dependent on auxiliary operations such as receiving, handling, storing and shipping. Failure or inefficiency in any of these will interfere seriously with complete utilization of the equipment. Supervision must be well enough rounded to recognize these problems and to see to it that competent engineers are a part of the team that installs and makes automation work. The type of labor used in the modern factory is gradually changing and, with automation the employee must have better basic knowledge of machinery and electrical controls.

More Automation Needed

If industry is to continue to make the type of progress that has raised our standard of living so

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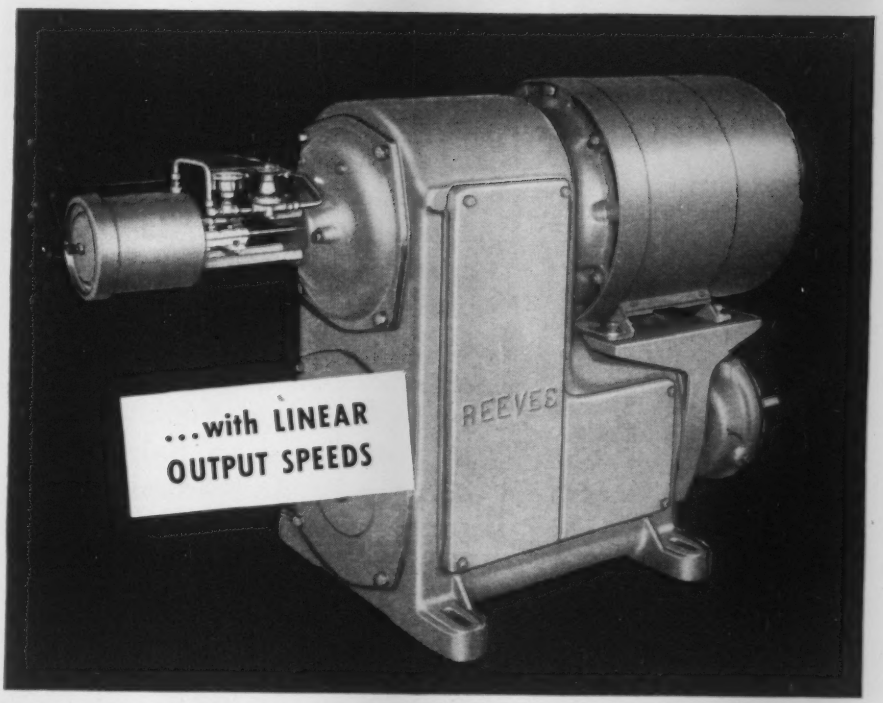

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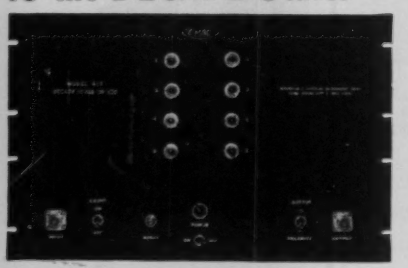

0.1 Microsecond Resolution

SPECIFICATIONS Model 412

INPUT CIRCUIT:
POLARITY: Positive pulses only. Negative pulse available at extra cost.
AMPLITUDE: Minimum amplitude of 5 volts required at low counting rates, increasing to 10 volts minimum at the maximum counting rate.
REQUIRED RATE OF RISE: Minimum of 10 volts per μsec.
INPUT IMPEDANCE: Greater than 5000 ohms.

RESOLVING TIME: 0.1 μsec.

MAXIMUM ACCEPTABLE UNIFORM RATE: 10mc or 10^7 counts/second, no lower limit on counting rate.

SCALING FACTOR: Decade Scale of 100 Neon light interpolation.

OUTPUT:
POLARITY: Positive or Negative pulse selected by front panel switch.

PULSE CHARACTERISTICS: Triangular pulse of approximately 1 μsec. rise time, 4 μsec. width and 50-60 volt amplitude.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, approximately 300 watts.

SIZE: 10½" x 19" x 13" deep

Also available Binary 10 mc Scaler Model 410

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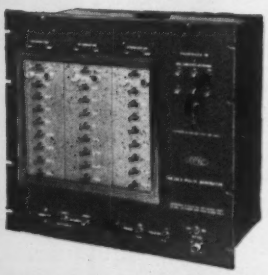

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SPECIFICATIONS

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PULSE WIDTH: .001 μsec to several uses, selectable
PULSE AMPLITUDE: From 100 volts to .006 volts in one db steps
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much over the past two or three decades, it must plan on more and more automation in production lines. The lower costs and greater production volumes will depend on how good and timely the judgment is that fosters the changes to automation. There will be even greater need for technically trained personnel which is already a problem of considerable magnitude. It will be necessary to incorporate better maintenance features into designs because maintenance costs are usually very high in automatic operations. Selection of help must improve to fit people to this type of work. Training programs on everything from economics to electronics must be improved so that operators have better understanding of their jobs. The basic human urges for physical accomplishments must be provided for people on automatic operations. Supervision must be better, both technically and in basic human understanding, to make these things work effectively.

From a paper entitled "Problems of Administration and Supervision in the Automatic Factory" presented at the Annual Meeting of ASME in New York, Dec., 1953.

STRAIGHT LINE TRANSFER VS ROTARY INDEX

By W. B. SHIMER
Master Mechanic
DeSoto Div., Chrysler Corp.
Detroit, Mich.

MAGIC WORD of the new industrial age, automation is many sided, complex, and probably misunderstood. To define it is difficult. It will be useful here to describe its anatomy. Automation is made up of integrated automatic machines and means for conveying parts between these machines. The goals of automation are reduction of manual labor and production of precision parts in very large volumes, to reduce costs in all phases of product manufacture. Automation has made wonderful inroads, but there are also blind alleys in this, as in other new production concepts. Industry should look carefully before they are caught up by this industrial magic. They should keep in mind

at all times the goals of automation, and above all, season their decisions with good common sense. One of the most important decisions industry must make concerns the general type to be used.

One example of automation is the rotary index machine, by no means a newcomer. If one can judge by the number of these machines now in use, it can be said that they are well accepted components in overall automation schemes. Yet index machines are uncommonly expensive to build and service. In their various types — trunnion, chucking, and carrousel—the original cost is often equal to the cost of the labor they replace. Movement of parts to and from index machines often calls for complicated mechanisms not dissimilar to those in Rube Goldberg cartoons. And, because of the cost of the unusual components required to permit the index machine to perform its magic, they are usually difficult to maintain.

In the DeSoto Fire Dome V-8 Engine Plant, straight-line transfer type machines are used in preference to the index type. Most successful consist of a series of single-purpose automatic machines connected by rails. In principle, these machines are a series of individual drill press and milling machines with rails for sliding parts from one machine to another by a pusher or transfer bar. The feed mechanisms are self-contained within each unit; no close accuracy is required between units.

Our machine lines now for pistons and rods consist of the most modern rotary index and other type multistation machines. Nevertheless, as contrasted to our transfer machines, these lines are less dependable, require more supervision and maintenance than we believe is necessary if unitized transfer machines were used. Furthermore, our present piston and connecting rod machining lines are more susceptible to fluctuation of production rate and scrap produced, as compared to parts manufactured on transfer machines.

From a paper entitled "Common Sense Automation" presented at the anual Westinghouse Machine Tool Electrification Forum at Buffalo, N. Y. in April 1954.

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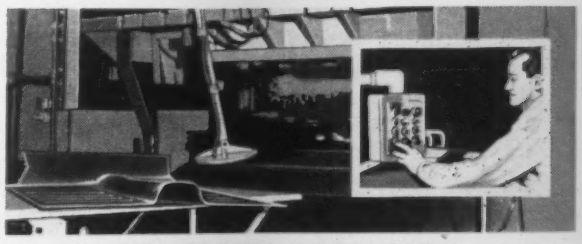

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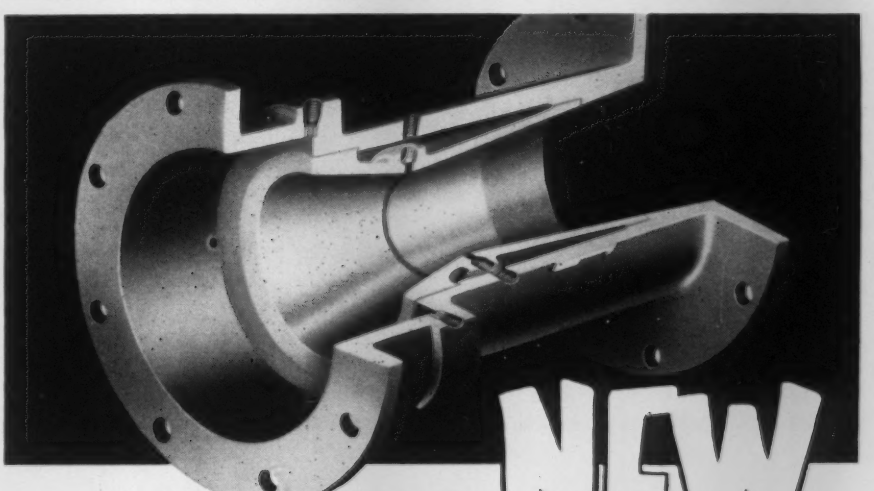

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AUTOMATION DOLLARS AND CENTS

By E. M. HICKS
Vice President and Manager
Grinding Machine Div.
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Worcester, Mass.

I SHOULD LIKE to make a few comments about the type of economic problems which are involved in consideration of automation decisions and to illustrate a typical study which is made in my example by use of the MAPI formula. In my opinion, all decisions on automation must, in the last analysis, be economic decisions. After the design engineers have completed their work of laying out the project, it is then necessary to estimate the cost of the equipment and all of the savings which can be expected to result. The decision in each case must stand on its own feet and, as mentioned above, there is great need of a sound policy for evaluating each project.

In looking for operations which are likely to pay, chances are best on those products and those operations which have high labor costs. The stability of product design should be considered, and the proposed automatic equipment should be studied to see whether it can be readily converted to provide for minor design changes in the product. The complete processing of the part must be reviewed and in many cases minor changes in design will be needed to facilitate the automatic handling.

Consider a Workman

One other point which should be considered carefully is the probable attitude of labor to the introduction of machinery which will mean a reduction in the labor force. It can easily be proved that machinery does not eliminate jobs, but actually creates additional jobs in the long run. We must remember, however, that the workman who is displaced by a machine does not receive very much comfort from this long run explanation, as it does not help him to buy groceries and to support his family. In cases where jobs are eliminated by new machinery, we should be careful to see that the workmen affected are offered other suitable jobs, even if we have to carry a few extra people until such time as they can be placed satisfactorily. It is much better to incur this small cost than to risk the opposition to new equipment by the working force.

Buy Automation?

The case example selected is a comparison of two alternative new installations and assumes that a decision to purchase new equipment has already been made. With slight adjustments the same method can be used to determine whether to replace existing old equipment with either automatic or conventional new machinery. For background information, a brief description of the two proposed types of new equipment will be helpful.

Machine *A* is the standard hand loaded crankpin grinder which, in an oversimplified description, consists of a base on which is mounted a grinding wheel unit and a pair of offset synchronously driven workholders to rotate the crankshaft around the pin to be ground. In the case of an 8-cylinder V-8 engine crank, there are four pins to be ground and the operator manually indexes the crank angularly after releasing the work-holder clamps and longitudinally by moving the machine table between the grinding operation on each pin. The operator must be in constant attendance during the complete operation and can, therefore, operate only one machine.

Machine *B* is a fully automatic transfer type crankpin grinder which, for a V-8 crankshaft, is equipped with four grinding stations (one for each crankpin on the shaft). There is automatic transfer equipment which moves the crankshafts progressively from one station to the next. Since a pin is ground at each station, a finished crankshaft is completed with each cycling of the machine, the finished shafts being delivered back to the conveyor line from the last station. The shafts moving from one grinding station to the next are automatically indexed angularly and longitudinally. One operator is required to observe the functioning of the machine and make any necessary adjustments.

One Method of Analysis

TABLE 1 compares the operating advantage for one year of Machine *A* as compared with Machine *B*. Without going into detail on the basis for these savings figures, you will note that savings have been shown wherever it is possible to determine a definite advantage for one machine or the other. The largest saving in this case, of course, is direct labor because only one operator is necessary on the automatic machine as compared with five for the conventional type machines. Since the automobile plant which is considering this purchase normally operates on two shifts, the saving is a total of eight operators.

You will note that the net operating advantage in favor of the automatic machine amounts to $57,604 per year, and this amount is transferred to line 9 of TABLE 2. We also insert on TABLE 2 the cost installed of each type of machine, the estimated service life, and sal-

Table 1—Operating Advantage (Next year)

Income Advantages	"A"—Hand Operated Crankpin Grinder	"B"—Automatic Crankpin Grinder
1. Superiority of product		x
2. Increased output	.....	.....
3. Other	.....	.....
Cost Advantages		
1. Direct labor (8 operators)		$42,000
2. Indirect labor (10%)		4,200
3. Fringe benefits cost (22%)		10,164
4. Floor space		27
5. Power (18 HP—KWH/.013)	$ 697	
6. Property taxes and insurance (1% of capital cost difference)	790	
7. Other (grinding wheel saving)		2,700
	$1,487	$59,091
Net operating advantages	.....	$57,604

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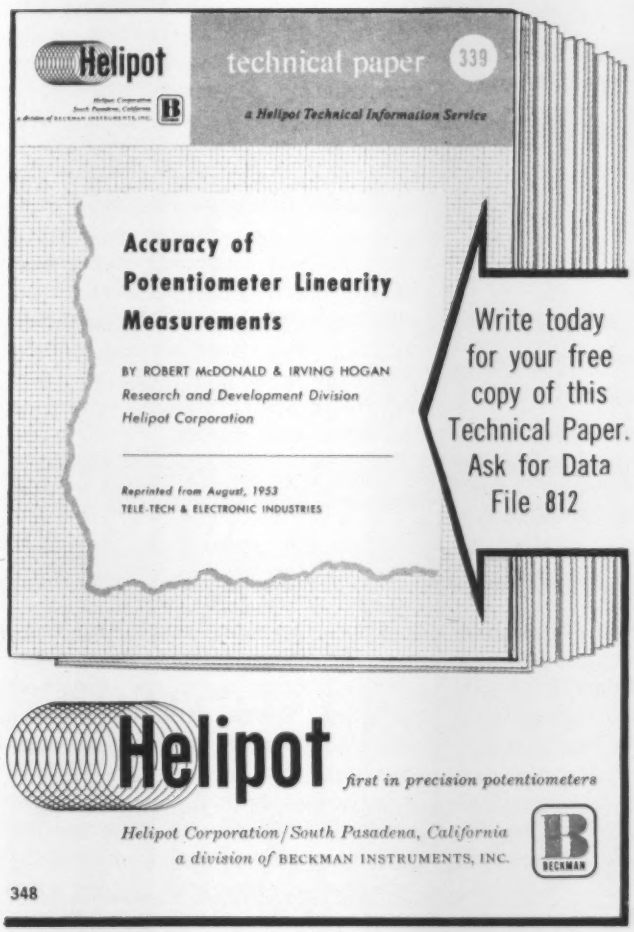
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technical paper 339
a Helipot Technical Information Service
Accuracy of Potentiometer Linearity Measurements
BY ROBERT McDONALD & IRVING HOGAN
Research and Development Division
Helipot Corporation
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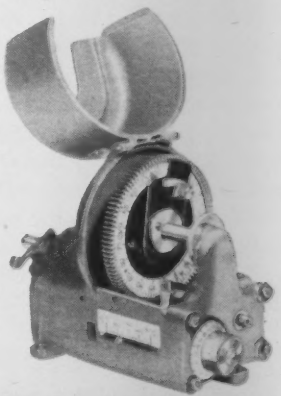

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Table 2—Comparison of New Machines

	"A"—Hand Operated Crankpin Grinders (5)	"B"—Automatic 4-Station Crankpin Grinder
1. Cost installed	$201,000	$280,000
2. Service life	15 years	15 years
3. Estimated salvage value	$ 1,105	$ 1,040
4. Salvage ratio	.55	.37
5. Formula (%)	10.1	10.2
6. Interest (%)	10.0	10.0
7. Total(%)	20.1	20.2
8. Adverse minimum	$ 40,401	$ 56,560
9. Operating inferiority	$ 57,604	.....
10. Total adverse minimum	$ 98,005	$ 56,560
11. Gain next year from installation		$ 41,445

vage value at the end of that life. The remainder of the calculation is made in accordance with empirical formula procedure and you will note that what is quaintly called the "Adverse Minimum" is less for the automatic machine than for the hand operated machines by $41,445. It should be understood that this gain is over and above the normal interest return on the capital investment which is included in the calculation for each type machine. The decision in this case is obviously in favor of the purchase of the automatic machine.

In closing let me recapitulate some of the questions which must be asked when considering automation or other modernization projects:

1. Have we selected the job which promises the greatest possibility of savings?
2. Is the job one with a relatively high labor cost?
3. What is the situation as to product design stability?
4. Has the proposed equipment been studied for ease of maintenance and changeover flexibility for design changes when they arise?
5. Have we the skilled mechanical staff required to maintain automatic equipment or can it be obtained readily?
6. Has labor acceptance of the proposed equipment been determined?
7. Has down time for tool maintenance been given sufficient consideration?
8. And above all—will it pay?

From a paper entitled, "Economic Problems of Replacement" presented at the Annual Meeting of ASME in New York, Dec., 1953.

ENGINEERING THE AUTOMATIC FACTORY

By R. P. GENEREAU
Engineering Dept.
E. I. du Pont de Nemours & Co.
Wilmington, Del.

IN A MODERN chemical plant a few men operate vast assemblages of equipment. There are tall towers and a maze of piping. You see few people and it is quiet. In a centralized, spotless control room there are panels of instruments with the process flow graphically traced through control buttons. There are lights and signals and communication to critical spots in the plant.

The prime items of plant economics are low capital investment, low working capital, low manufacturing and sales cost, and plant capacity commensurate with product demand. In our company, the final measure of effectiveness is return on investment. We define return on investment as net earnings after all expenses and taxes divided by the total investment, which includes both working capital and permanent investment.

Representative of the chemical industry, manufacturing buildings and equipment are generally 60 per cent of the cost of the plant. Utilities and other service facilities account for the remaining 40 per cent. The 60 per cent for manufacturing facilities breaks into 15 per cent for buildings, and 45 per cent for the equipment that really produces the product. In other words, less than half the cost of a plant is for the actual manufacturing equipment.

From Design to Operation

Operability of the plant must be woven into the design. This means a carefully studied arrangement of equipment and controls and flow of materials. There must be an economical minimum of operators. Inventories in raw, intermediate, and finished materials must be economical but in operable balance. Otherwise, the working capital would be excessive. The design must permit low cost maintenance. It must provide flexibility to permit economical modifications to process and capacity increases in the future. It means a plant with safety designed into it.

An essential feature of the chemical industry is its vulnerability to loss of yield. Because it is generally a high-capacity, high-cost facility, a mistake in plant operation can eat up a lot of money quickly. Operators and automatic devices must function dependably and earn their way.

The demand for quick plant startup and early realization of design capacity dictate meticulous construction. Intricate machinery and piping must be installed and tested for performance. The greater intricacy of instrumentation and electrical facilities demands competent, trained people to install them properly, insuring correctness at the start. Faulty installations, causing losses of production during startup, may cause several months idle time or require earnings from several years at capacity operation to offset such faults.

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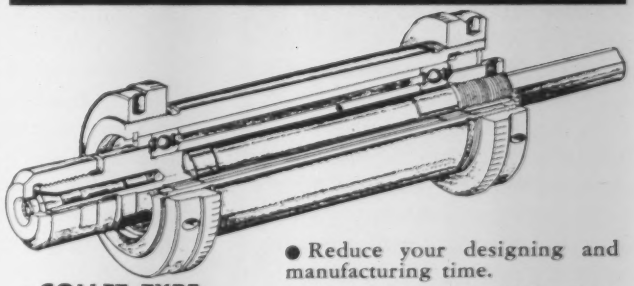

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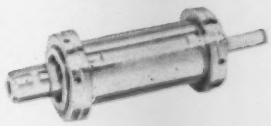

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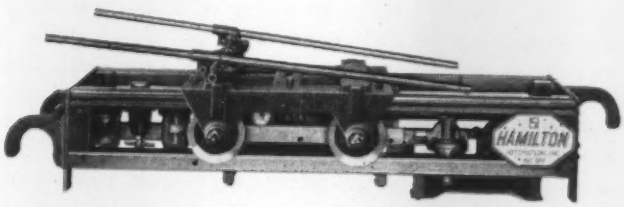

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as well as material incentives, causes us to do a better job. Important is the continuing association of engineers with the operating people. Our engineering is not done for individual gains, but for the over-all interest of the company, in which each individual, stockholder, and employee profits, and the company advances.

Our engineering department has five divisions. One is development engineering. Its primary function is research and development in the fields of chemical and mechanical engineering, applied physics for process control, and materials of construction. These engineers, scientists too, are delving into the unknown, seeking new or better means for carrying out chemical reactions and separations, better materials of construction, creating automatic machinery and control devices not otherwise available. Such controls permit more precise feed rates of materials, more precise control of temperatures and pressures, with feedback to effect automatic operation. These research men have work programs with a bearing on immediate problems, and a program of fundamental research hoped to have future value. These men must anticipate the needs of increasing pressures and temperatures, and of future chemical and mechanical processing. These men not only feed their information to the design engineers in reports, they assist directly in the solution of difficult engineering problems in current design and construction projects. They maintain contact with university research, technical society activities, and plant technical groups. These activities give them plenty of incentive to contribute to engineering knowledge because they can see the results.

Our engineering service division consists of a field section and a consulting section. Younger engineers are assigned to plants for work on studies for improving capacity and quality, the reduction of operation costs, and also to work on new process developments. The average field engineer spends about three years each at three or more plants. This group of men is a prime source of experienced and specially-trained engineers for assignment to more responsible work in design, construction, research, and consultation.

The consulting section comprises groups of experienced specialists with younger assistants. They cover all fields of engineering involved in the company's business. They include chemical engineering, mechanical engineering, instrumentation, engineering materials, maintenance, materials handling, utilities such as steam and electrical generation and distribution, refrigeration and air conditioning, water supply and treatment, prevention of air and stream pollution, and industrial engineering. Their work is on problems for existing plants and assistance to design for new plants. These engineers are charged with the responsibility of keeping ahead of the field in their specialty. Their incentives are a diversity of interesting problems, the heavy demand for their services, and the concrete results of their work.

The design division correlates the engineering effort that results in drawings and specifications for construction. Our broad diversification of chemical manufacture has prompted the establishment of ten industrial departments, each having broad responsibilities in particular fields of products. In our design division, we assign a design project manager to supervise all of the design work done for a given industrial department. This permits him to become thoroughly familiar with the people and developments of that department.

The design project manager is responsible for over-all project administration and for process design. Engineers, primarily chemical and mechanical, and process designers report directly to him. He retains administrative responsibility for but is relieved of the technical design of the service facilities, which is the responsibility of senior engineers in power, electrical, structural, civil, and instrumentation. All portions of the plant are tied together and to the process facilities by frequent conferences led by the Design Project Manager, and by interlocking schedules.

Construction commences when design is about 60 per cent complete. This dovetails the entire project and hastens the time of startup. Construction personnel review design as it is developed, make constructive suggestions, and thus are able to sequence their work more knowingly. Design personnel visit the construction site to facilitate interpretations and learn how to do a better job the next time.

Engineering Teamwork

Our means for bringing all these engineering functions into close harmony are many. A prime one is interchange of personnel. The best way to understand the other fellow's problems is to solve some of them yourself. Another lies in our planning and scheduling. All phases of work are planned out by the people who are to do the work. Another is a training program which enables engineers to learn of the broader aspects of the engineering work. One major aspect is bridging the engineer's change from academic to industrial work. Horizons widen, and one's own work ceases to be the most important; it becomes properly integrated to the whole.

Our engineers are free to think, speak, and create. All of these elements contribute to the successful engineering of a modern chemical plant. Out of it can come a simple plant, or a complex automatic plant — it depends on the need and the economic justification. We must be careful to apply automation only when and where it will improve quality or increase productivity; not where a simple gaging stick will do the job. We still need people to guard the automatic devices.

We in the chemical industry are not reluctant to apply the techniques of automation; in fact, we are encouraged to do so because we have the added complication of gases, liquids, and solids. We deal in infinite combinations and kinds of materials. We must advance boldly, develop the ideas, harness the power, and become skilled in the use of all the tools we can devise, never forgetting that they are tools for man's use and not to use men.

From a paper entitled "Engineers, Engineering and the Automatic Factory" presented at the Annual Meeting of ASME in New York, Dec., 1953.

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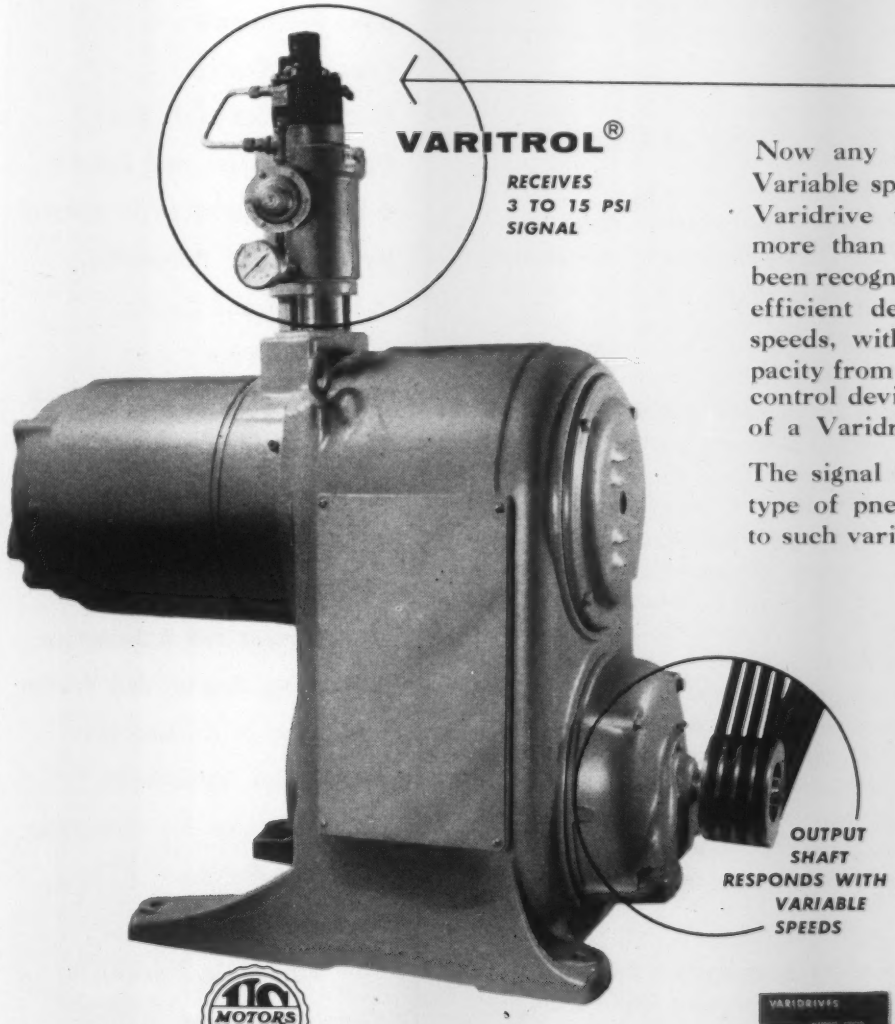

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IT IS with genuine pleasure that we welcome you as a reader of AUTOMATION. We hope you will find, in this and later issues, that you can use the economically practical ideas presented by the authors.

To meet the American business ideal of "more things for more people at lower costs", the increased use of automatic operations or automation is a necessity. We plan to give you practical, factual articles to help in applying the principles of automation. Articles of this type take considerable time for research and preparation, but we have been working on them for many months. Already, one hundred and twenty are in preparation. At the right we have listed the major topics which will be covered in AUTOMATION.

Automation is not confined to transfer machines or materials handling. These are but single manifestations of the evolution toward automatic operation. Similarly, it is not confined to electronic control, instruments, computers, or feedback. These are but phases of a bigger overall practical industrial and commercial development. It is a vital and powerful movement sparked by the greatest demand for goods in history.

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Whether you design, produce or manage, you have the responsibility for lowering unit costs in manufacturing, processing or handling of goods and, we are sure, you will find AUTOMATION of real value. Read it each month and pass along to your associates.

EDITOR

AUTOMATION TOPICS:

Data Processing
Computer Control
Electric Drive and Control
Electronic Drive and Control
Drive and Feedback in Control
Hydraulic and Pneumatic Drive and Control
Instrumentation
Mechanical Drive and Control
Tape Controls
Economics of Automation
Handling and Conveying
Maintenance in Automation
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A PROVED EQUATION—

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AUTOMATION—The most thought provoking word in industry today—has almost as many definitions as it has uses. Perhaps the simplest and yet its most accurate description is that "Machines relieve men of tedious and repetitive jobs."

To a great extent, the ever increasing requirements of the automotive industry have been responsible for the steady progress in the design of automatic machines.

Today's radically changing economic conditions resulting in demands for still lower unit costs have been responsible for the accelerated pace in the design of fully "AUTOMATED" automatic machinery.

McKay has for many years been working in close cooperation with the major auto producers, the steel industry and fabricating plants in the development of Automated Machines that automatically take over sequential operations and combine operational functions in preparing and handling raw materials as well as processing and handling finished products.

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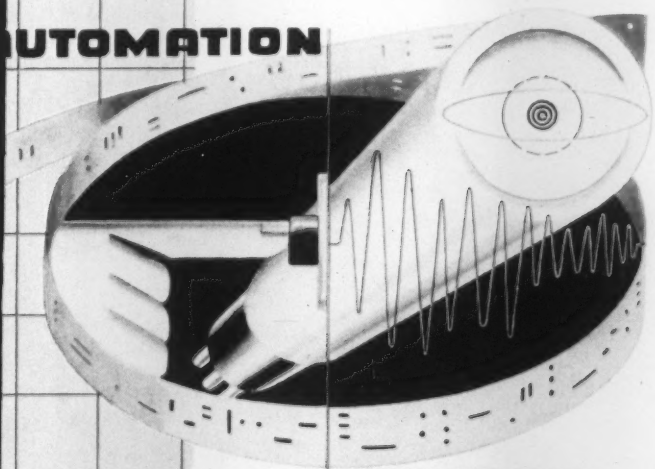

● The illustration here was designed to exemplify "Automation in Action." It is a composite of a few of the more familiar symbols created by artists to signify this new era of automation. It will be used hereafter to designate truly "automated" machines designed and built by McKay.

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Cutler-Hammer leadership in automatic electrical control has been recognized and respected over the entire 62 years since Cutler-Hammer pioneered the art with the very *first* automatic motor control feature ever offered by anyone, the no-voltage release in the Cutler-Hammer Bulletin 10 Motor Starter of 1892.

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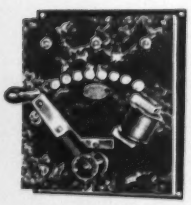

The "Kitty Hawk" of Automation

The very first automatic feature in motor control was the no-voltage release in the Cutler-Hammer Bulletin 10 Starter of 1892. The starter handle was held in the "on" position by an electromagnet and returned automatically to the "off" position whenever the power supply failed. This protected men at machines from sudden unexpected restarting, motors against burn-out due to the inrush of uncontrolled current.

CUTLER-HAMMER
MOTOR CONTROL
C-H